# Alameda Countywide Transportation Model Update

# Final Model Documentation

**August, 2015**

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# 1.0 Introduction

The purpose of this documentation is to present the procedures used for the most recent update of the Alameda Countywide models. The strategy for the update project was to add incremental improvements to the existing Alameda CTC models to refine the model performance. In summary, the model enhancements implemented in the update of the Alameda Countywide models included the following:

- Addition of traffic analysis zones (TAZ) in Alameda County to improve consistency with 2010 census tract boundaries and allow more detailed estimation of transit ridership in transit rich-corridors, near transit stations and in designated Priority Development Areas (PDAs),
- Update socioeconomic databases, based on local jurisdiction review, to reflect ABAG Projections 2013 data series (also referred to as the Sustainable Community Strategies),
- Incorporating enhancements to more accurately model bicycle trips through bicycle network coding of infrastructure and developing a bicycle trip assignment application,
- Recalibration and validation of the models to base year 2000 observed travel conditions for the entire model region using data from the MTC 2000 Household Surveys,
- Validation of the Countywide models to year 2010 traffic, transit and bicycle counts,
- Application of the Countywide models for new forecast horizons 2020 and 2040,
- Implementing travel time feedback into the forecast model application,
- Assigning transit park-and-ride vehicles in the highway assignments,
- Developing mid-day and off-peak vehicle assignments, in addition to peak hour and peak period assignments,
- Development of updated model performance measures, and
- Update MTC Consistency documentation.

## 1.1 Objectives of the Model Update

The updated Alameda Countywide models were developed to be consistent with the Metropolitan Transportation Commission (MTC) regional BAYCAST model methodologies The countywide model update included recalibration of all aspects of the models, including auto ownership, trip generation, trip distribution and the mode choice models. The remainder of this report documents the Alameda Countywide Model Update, incorporating the following elements:

- Updates to the Traffic Analysis Zone structure and transportation networks,
- Year 2000 base year calibration results,
- Year 2010 model validation results,
- Year 2020 and 2040 model forecast results,
- Updated model performance measures output, and
- MTC model consistency findings.

# 2.0 Traffic Analysis Zone Structure

TAZs are a fundamental building block used throughout the entire travel demand model structure, and, therefore, require a focused effort and consideration of issues in development and review. Based on the comments provided by the Task Force on the proposed methodology at the meeting and during the subsequent review period, the following guiding principles were finalized:

- 2010 Census Tract boundaries will represent the highest level of aggregation. Alameda TAZs will always have a boundary consistent with a 2010 Census Tract boundary, and nest precisely within Census Tracts,
- Alameda County TAZs will not split the new MTC Micro Analysis Zones (MAZs). Further, Alameda County TAZs will be defined so that MTC MAZs will nest within Alameda County TAZs,
- TAZ boundaries will ensure there is proper definition to differentiate between walk-access to transit markets. Smaller TAZ boundaries will be defined near major rail stations, ferry stops and bus stops, typically using a 0.25 mile radius edge as a starting point. Local street networks and census block boundaries will be used to define the TAZ boundaries near transit stations/stops,
- Park-and-ride lot locations will also be used to define TAZs. This will facilitate the assignment of park-and-ride vehicles to the roadway networks,
- Roadway networks will be an important feature for defining TAZ boundaries. At a minimum, all CMP facilities will define TAZ boundaries. This includes freeways and arterials,
- Boundaries will be defined to ensure that no more than one freeway interchange lies within an entire TAZ,
- TAZ boundaries will be developed to ensure that intersection turn movements can be properly generated by the roadway assignments,
- TAZ boundaries will be developed based on locations of future network, and
- TAZ boundaries will be developed to provide detail in areas that are expected to redevelop into smaller land parcels.

### 2.1 Existing TAZ Structure

The existing TAZ structure in the Alameda Countywide model is well-defined, and provides a valid starting point for TAZ refinement. There are 1,405 TAZs within Alameda County and 1,256 TAZs outside of Alameda County. Table 2.1 below provides a quick summary of the existing zone structure. It should be noted that there is a considerable gap between the last Alameda County TAZ (TAZ 1405) and the first TAZ outside of Alameda County (TAZ 2001 to TAZ 3597) to facilitate adding new TAZs in the future that will follow the same numbering pattern. The new Alameda County TAZs were created within this first gap of TAZs.

**Table 2.1 Existing Alameda Countywide Model TAZ Structure – by Jurisdiction**

| TAZ Number | Geographic Location |
|---|---|
| 1 – 1405 | Alameda County |
| 2001 – 2052 | West Contra Costa County |
| 2101 – 2148 | South Contra Costa County |
| 2201 – 2233; 2847 – 3205 | Santa Clara County |
| 2301 – 2326 | San Joaquin County |
| 2501 – 2690 | San Francisco County |
| 2691 – 2846 | San Mateo County |
| 3206 – 3353 | Other Contra Costa County |
| 3354 – 3433 | Solano County |
| 3434 – 3460 | Napa County |
| 3461 – 3546 | Sonoma County |
| 3547 – 3597 | Marin County |

### 2.2 Proposed Changes to the TAZ Structure

The proposed changes to the TAZs fall under five broad categories, however, all of the principles were used to define the new boundaries:

1. Changes in view of the need for TAZs maintaining consistency with the 2010 Census Tract boundaries,
2. Changes to create smaller zones near major rail stations, ferry stops and bus stops,
3. Changes to have MTC's proposed MAZs nest within the TAZs,
4. Overlay added TAZs around transit park-and-ride lots to allow drive-access to transit autos in the highway assignments, and
5. Changes to create smaller TAZs caused by the definition of the CMP roadway network.

In summary, a total of 1,175 new draft TAZs were created for the Alameda Countywide Model using the adopted principles. Table 2.2 summarizes the total number of existing and proposed new TAZs by County Planning Area. The remainder of this memorandum details the specific changes and the justification used to define the new TAZ boundaries under the above five principles.

**Table 2.2 Proposed TAZ Changes in Alameda County**

| Planning Area | Name | Current Number of TAZs | Number of TAZs After Proposed Changes |
|---|---|---|---|
| 1 | North County | 535 | 597 |
| 2 | Central County | 248 | 288 |
| 3 | South County | 171 | 211 |
| 4 | East County | 451 | 484 |
| **Total** | | **1,405** | **1,580** |

### 2.2.1 Maintaining Consistency with the 2010 Census Tract Boundaries

The Census Tract boundaries represent the highest level of aggregation. A comparison of the Alameda Countywide Model TAZs and the new 2010 Census Tract boundaries indicated that the majority of TAZs are nested within the Census Tracts. There are only twenty-seven zones that straddle multiple Census Tracts. In those cases, it was proposed to either move the boundary of the TAZs or to split the TAZs such that they will nest precisely within 2010 Census Tracts.

### 2.2.2 Creating Smaller Zones Near Major Rail Stations, Ferry Stops and Bus Stops

Smaller TAZs ensure that the zone system can properly delineate walk-access to transit markets. This may be an important consideration as new redevelopment areas are proposed in close proximity to major transit stations and high-frequency services, as a large TAZ structure exaggerates the market that has walk-access to transit and can lead to an overestimate of transit usage. As a starting point, a quarter-mile radius from each major rail or ferry station in Alameda County was used to identify places where smaller zones might be warranted. All of the TAZs which are partially or fully located inside the quarter-mile walk-access catchment area were evaluated for possible zone split or boundary refinement. Changes were proposed to TAZs near all but three of the BART stations in Alameda County. No TAZ changes are proposed around the following stations:

- 12$^{th}$ Street/Oakland City Center
- Lake Merritt
- Dublin/Pleasanton

The current TAZs are quite small near the 12th Street/Oakland City Center BART station and the Lake Merritt BART station; they are adequate to capture the walk-access to transit markets. Table 3 summarizes the number of additional TAZs added in the vicinity of each transit station area.

**Table 2.3 Proposed Added TAZs near Rail Stations and Ferry Terminals**

| Rail Station or Ferry Terminal | Number of Additional TAZs |
|---|---|
| 19th Street BART | 1 |
| Ashby BART | 6 |
| Bay Fair BART | 3 |
| Berkeley BART | 4 |
| Castro Valley BART | 3 |
| Coliseum BART | 1 |
| Fremont BART | 3 |
| Fruitvale BART | 2 |
| Hayward BART | 10 |
| Irvington BART | 3 |
| MacArthur BART | 5 |
| North Berkeley BART | 4 |
| Rockridge BART | 6 |
| San Leandro BART | 4 |
| South Hayward BART | 3 |
| Union City BART | 3 |
| Warm Springs BART | 2 |
| West Dublin/Pleasanton BART | 1 |
| West Oakland BART | 4 |
| Emeryville Amtrak | 4 |
| Oakland Jack London Square Amtrak | 1 |
| Hayward Amtrak | 4 |
| Fremont Amtrak/ACE | 1 |
| Livermore ACE | 2 |
| Alameda Ferry Main Street Terminal | 1 |
| Alameda Ferry Harbor Bay Terminal | 4 |
| **Total** | **85** |

### 2.2.3 Overlay TAZs around Rail and Ferry Stations with Park-and-Ride Lots

In addition to changing zone boundaries and splitting existing zones, a new set of overlay TAZs to represent the rail and ferry station park-n-ride lots in Alameda County were developed. Currently, the Alameda Countywide Model does not assign park-and-ride vehicles to the roadway networks. The creation of these overlay TAZs will facilitate assignment of the park-and-ride vehicle trips to more properly capture vehicle demand and congestion effects near stations. These TAZs will not be used to allocate landuse. Because these TAZs are meant to be overlaid on top of the regular TAZs, they are not added to the electronic TAZ shapefiles and do not have a spatial dimension so that vehicle trips can be assigned to the roadways.

### 2.2.4 CMP Network Considerations

The existing TAZ structure was reviewed in relation to the CMP network. For the most part, CMP facilities and existing TAZ boundaries align rather well. In just a few instances, new TAZs were defined where CMP facilities cut across the existing boundary of a larger existing TAZ. Example locations where new TAZs were created include near the intersection of I-238 and I-880 and along I-680 south of Sunol and north of Fremont.

Once draft TAZs were defined, maps of the TAZ splits were provided to the member jurisdictions and a final set of TAZs was developed. Table 2.4 summarizes the final ranges of TAZs by each jurisdiction represented in the Alameda Countywide models. Figures 2.2 through 2.4 show the additional final TAZs by planning area.

**Table 2.4 Final TAZ Ranges by Jurisdiction**

| Jurisdiction | Zone Number Range |
|---|---|
| Alameda | 461 - 530, 1463-1467 |
| Albany | 1 -13 |
| Ashland | 637 - 649, 1485-1486 |
| Berkeley | 14 -114, 1406-1423 |
| Castro Valley | 602-624, 1478-1483 |
| Cherryland | 650-654, 1487-1488 |
| Dublin | 941-1052, 1549-1569 |
| Emeryville | 115-126, 1424-1428 |
| Fremont | 802-917, 1519-1544 |
| Hayward | 655-768, 1489-1507 |
| Livermore | 1192-1375, 1575-1578 |
| Newark | 918-940, 1545-1547 |
| Oakland | 127-454, 1401-1405, 1429-1462 |
| Piedmont | 455-460 |
| Pleasanton | 1053-1191, 1570-1574 |
| San Leandro | 531-601, 1468-1474 |
| San Lorenzo | 625-636, 1484 |
| Union City | 769-801, 1508-1517 |
| Remainder of Alameda County | 1376-1400, 1579, 1580 |
| West Contra Costa buffer zones | 2001-2052 |
| South Contra Costa buffer zones | 2101-2148 |
| Santa Clara buffer zones | 2201-2233 |
| San Joaquin buffer zones | 2301-2326 |
| Remainder of Bay Area Counties | 2501-3597 |
| Gateway zones | 4455-4485 |

**Figure 2.1**

Added Traffic Analysis Zones - Planning Area 1

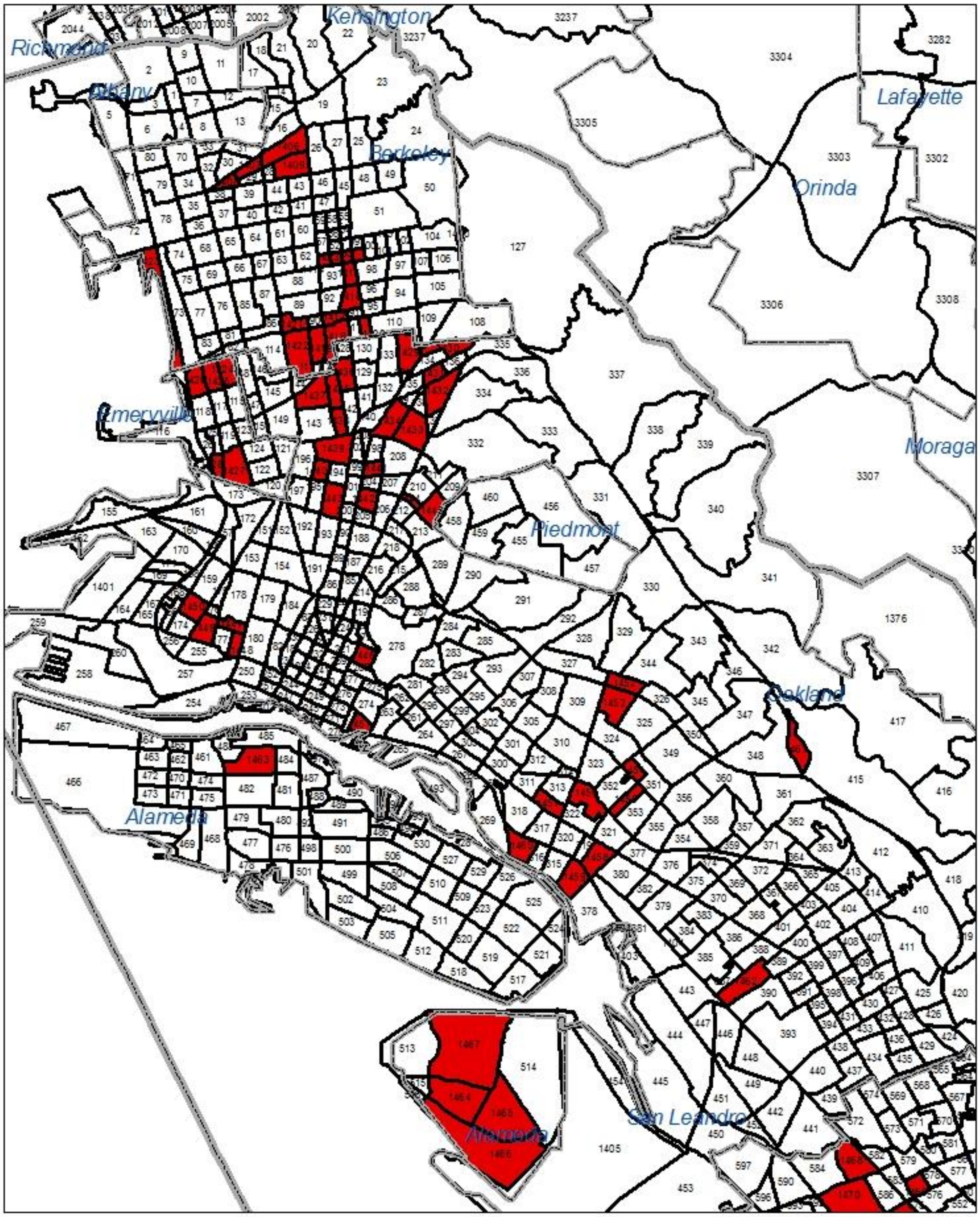


**Figure 2.2**

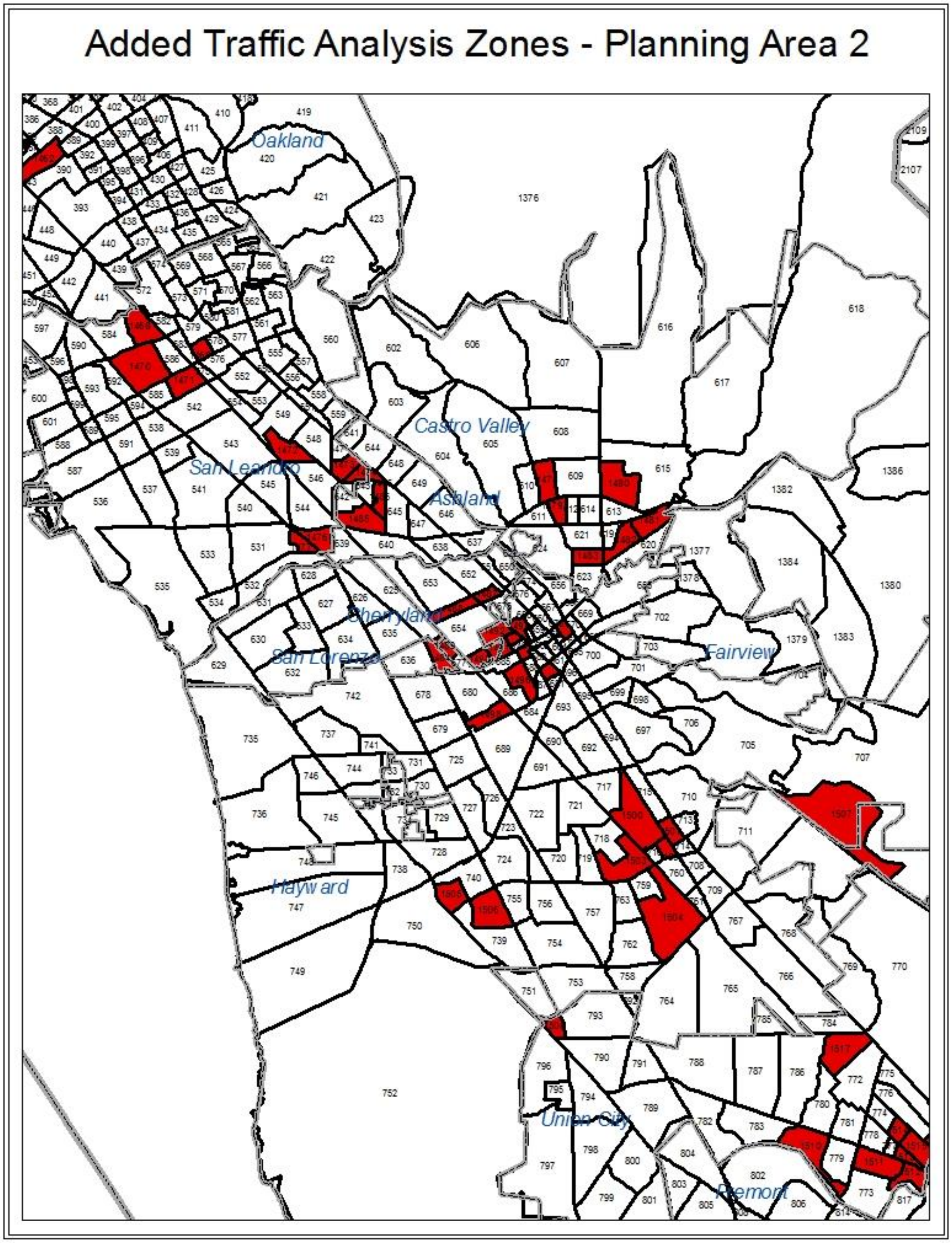
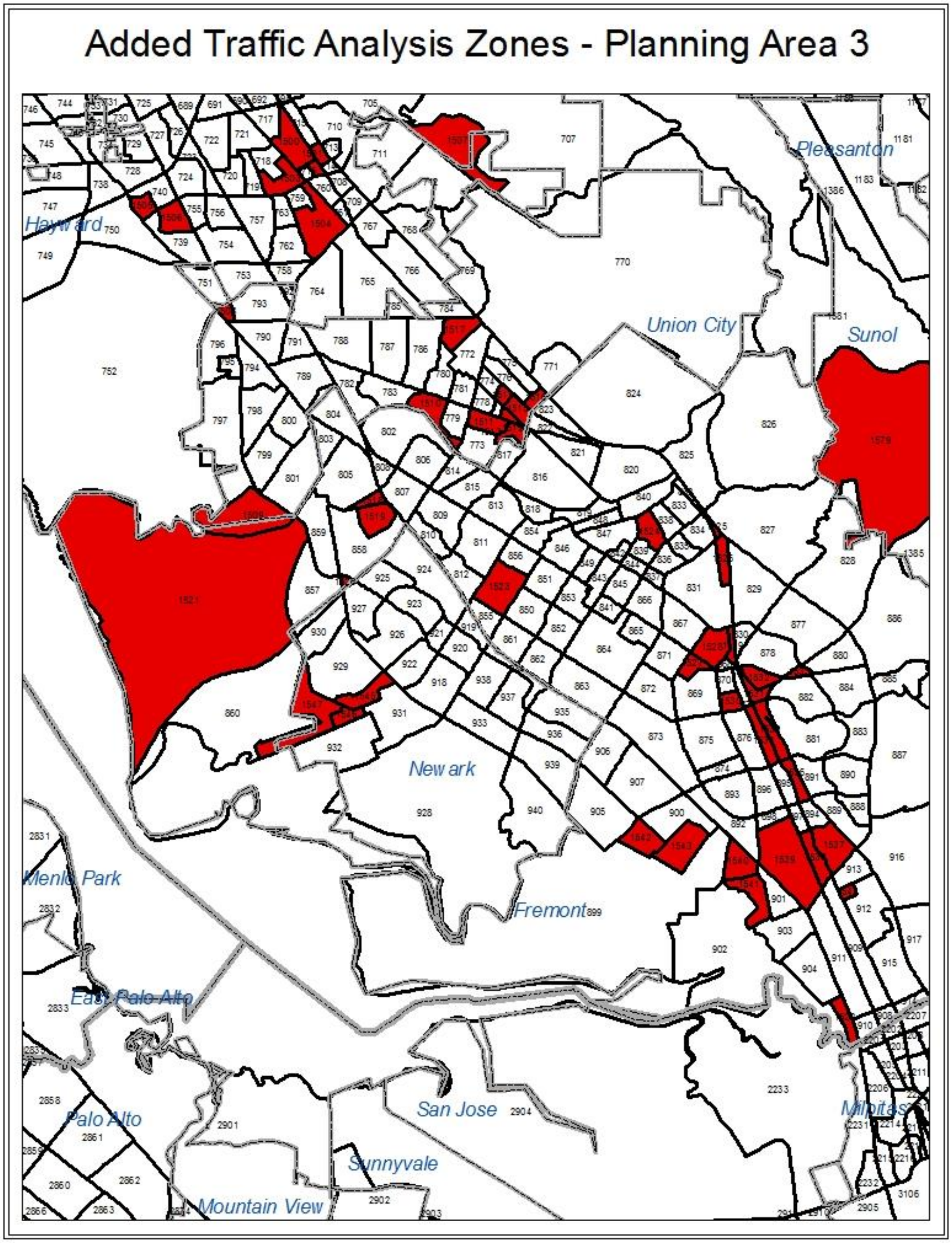
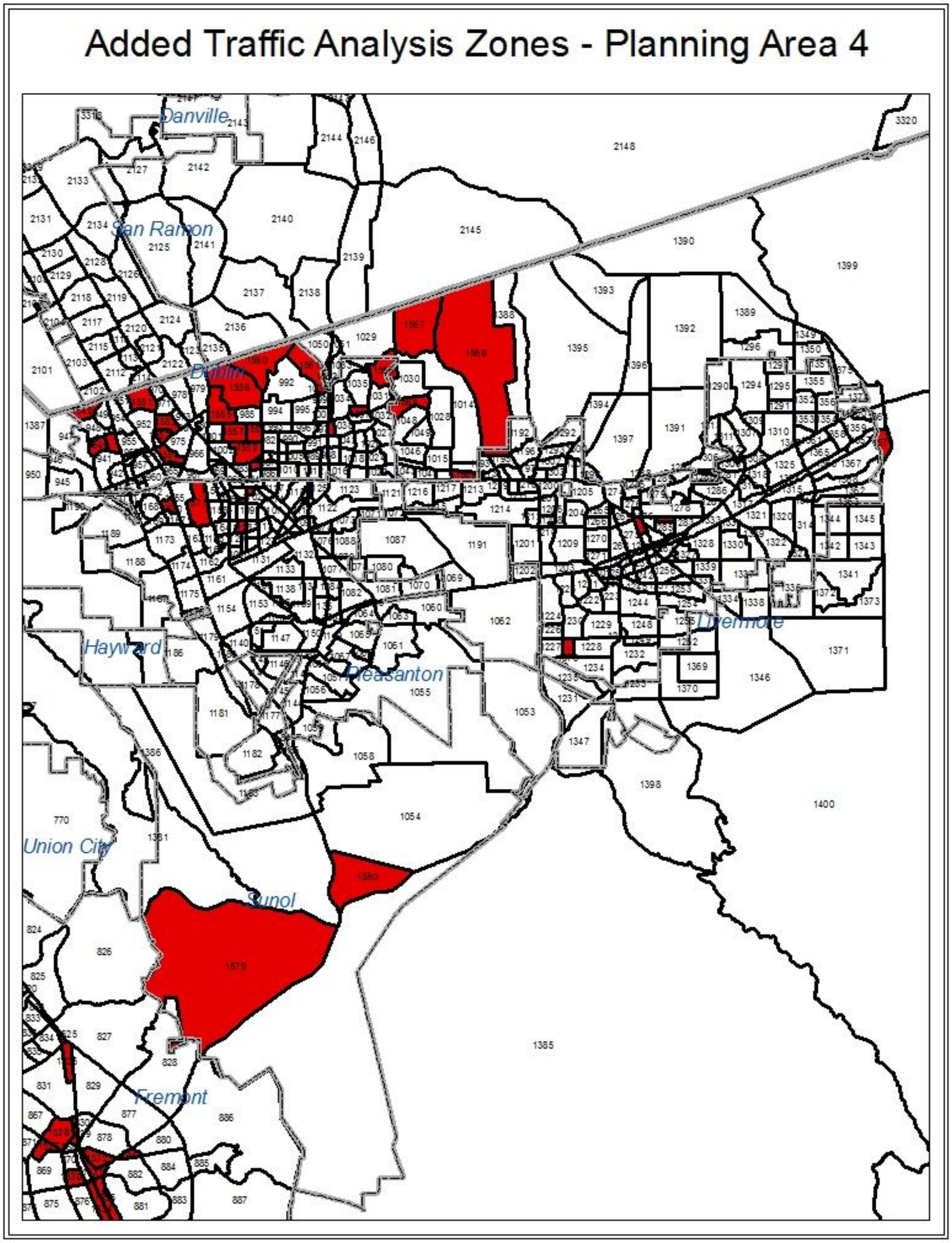

Added Traffic Analysis Zones - Planning Area 2
Oakland
Castro Valley
San Leandro
Ashland
Cherryland
San Lorenzo
Fairview
Hayward
Union City
Fremont

**Figure 2.3**



Added Traffic Analysis Zones - Planning Area 3
Hayward
Pleasanton
Union City
Sunol
Newark
Fremont
Menlo Park
East Palo Alto
Palo Alto
San Jose
Sunnyvale
Mountain View
Milpitas

**Figure 2.4**


Added Traffic Analysis Zones - Planning Area 4
Danville
San Ramon
Dublin
Pleasanton
Livermore
Hayward
Union City
Sunol
Fremont

# 3.0 Transportation Networks

The Alameda County Transportation Demand Model requires input networks to define the road and transit systems for each year and analysis scenario. The road and transit networks are based directly on the networks from the MTC travel model. The model update project essentially maintained the existing network coding conventions, but updated the projects to reflect the adopted Plan Bay Area. In addition to the typical roadway and transit networks, the model update included a detailed representation of bicycle infrastructure in the simulation networks to support the model enhancements to estimate bicycle trips.

## 3.1 Overview of the Previous Alameda Countywide Model Roadway Networks

The travel model road networks were built with the general rule of roads that carry traffic through an area as opposed to just serving fronting properties. The network includes the following road types:

- Freeways
- Freeway ramps
- Metered ramps
- State routes
- Arterial streets
- Collector streets that carry traffic through neighborhoods to adjacent neighborhoods

### 3.1.1 Functional Classification

Functional classification is a hierarchy of street function that is used to designate speed, capacity, access control and other characteristics. The Alameda County Model uses the MTC Functional Classification, as shown in Table 3.1.

### 3.1.2 Capacity

The travel model uses an estimate of street capacity on each segment. The capacity is a one-hour capacity (vehicles per hour) and is generally derived from the functional classification and the area type (Table 3.1). However, there are other characteristics such as type of traffic control or presence of pedestrians that may be important for the model.

### 3.1.3 Number of Lanes

The numbers of lanes coded in the model represent the minimum number of through-lanes in each direction on the segment. Turn lanes are not included in the lane total, as the additional capacity provided by turn lanes is assumed in the higher functional classifications such as expressway or major arterial. If a segment has a different number of lanes in one direction than the other, then it should be coded that way.

The Alameda County Model uses coding for auxiliary lanes, which are not actively used in the MTC model. The total number of directional lanes including auxiliary lanes is coded on each segment. If the AUX field is coded, indicating that one of the lanes terminates at a ramp rather than continuing through to the next segment, the model assumes one-half the normal capacity for that auxiliary lane.

## Table 3.1 MTC Functional Classification

### Speed/Capacity Table (With revised speeds)

| | | Freeway to Freeway | Freeway | Expressway/Highway | Collector | Ramp | Centroid Connector | Arterial | Metered Ramp | TOS Freeway | | Special Type | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area Type** | **Variable** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | | **10** | |
| Core (0) | Capacity | 1,700 | 1,850 | 1,300 | 550 | 1,300 | N.A. | 800 | 700 | 1,900 | (A) | 1,350 | (G) |
| | Speed | 40 | 55 | 25 | 10 | 25 | 15 | 20 | 55 | 25 | | | |
| CBD (1) | Capacity | 1,700 | 1,850 | 12,300 | 600 | 1,300 | N.A. | 850 | 700 | 1,950 | (B) | 1,500 | (H) |
| | Speed | 40 | 55 | 25 | 10 | 25 | 20 | 20 | 60 | 30 | | | |
| UBD (2) | Capacity | 1,750 | 1,900 | 1,450 | 650 | 1,400 | N.A. | 900 | 800 | 2,000 | (C) | 1,530 | (I) |
| | Speed | 45 | 60 | 30 | 15 | 30 | 25 | 25 | 65 | 40 | | | |
| Urban (3) | Capacity | 1,750 | 1,900 | 1,450 | 650 | 1,400 | N.A. | 900 | 800 | 1,780 | (D) | 900 | (J) |
| | Speed | 45 | 60 | 30 | 20 | 30 | 25 | 25 | 50 | 20 | | | |
| Suburb (4) | Capacity | 1,800 | 1,950 | 1,500 | 800 | 1,400 | N.A. | 950 | 900 | 1,800 | (E) | 950 | (K) |
| | Speed | 50 | 65 | 35 | 25 | 35 | 30 | 30 | 45 | 25 | | | |
| Rural (5) | Capacity | 1,800 | 1,950 | 1,500 | 850 | 1,400 | N.A. | 950 | 900 | 1,840 | (F) | 980 | (L) |
| | Speed | 50 | 65 | 40 | 30 | 35 | 35 | 30 | 50 | 35 | | | |

Upper entry: Capacity at level of service E in vehicles per hour per lane; i.e., ultimate capacity. Lower entry: Free-flow speed (mph)

**Notes:**

(A) TOS Fwy (AT = 0,1); (B) TOS Fwy (AT = 2,3); (C) TOS Fwy (AT = 4,5); (D) Golden Gate; (E) TOS Fwy (AT = 0,3); (F) TOS Fwy (AT = 4,5); (G) Expwy TOS (AT = 0,1); (H) Expwy TOS (AT = 2,3); (I) Expwy TOS (AT = 4,5); (J) Art Sig Coor. (AT = 0,1); (K) Art Sig Coor. (AT = 2,3); (L) Art Sig Coor. (AT = 4,5).

### 3.1.4 Speed

The model requires input uncongested speeds for each segment. The slowing down effects of congestion and interaction with other vehicles are accounted for within the traffic assignment process. Typical input speeds used in the model are shown in Table 3.1.

The speeds used in a travel model do not in general coincide with the posted speed limit or with radar speed surveys, and are not literally "free flow" speeds. The model speed should represent the average speed during off-peak hours and with congestion for vehicles to traverse the segment, including delays at signals or stop signs. The model speeds can be thought of as the "11:00 P.M." speed, when there are few conflicts with other vehicles, but signals are still operating normally at intersections.

The MTC model and prior versions of the Alameda County Model always used the speed values shown in Table 3.1. The P09 version of the Alameda County Model allows for direct coding of segment speeds that can vary from the values in the table. These values are used in the highway assignment process.

### 3.1.5 Ramp Metering

The MTC model defines network characteristics for metered ramps. However, the network attributes were never coded. The P07 version of the Alameda County Model implemented detailed ramp metering capacities and speed-flow relationships for all existing and proposed metered ramps in Alameda County. These capacities were maintained during the model update. Caltrans staff from the District 4 Division of Operations, Office of Traffic Systems, Ramp Metering Unit provided information on ramp meters on all state highways in Alameda County, including the dates when meters became or would become operational.

**Ramp Metering Rates in the Travel Model.** Metered ramps in Alameda County operate using sensors which detect the flow rate on the mainline freeway and adjust the metering rate accordingly. Caltrans adjusts the metering strategy at each individual location to balance freeway mainline operations with queues and operations affecting local streets. This process cannot be easily replicated in a travel demand model. Therefore, it was necessary to estimate average hourly rates for each metered on-ramp in Alameda County for the A.M. and P.M. peak periods.

**Existing Metering Rates.** Existing average ramp metering rates for travel modeling purposes were estimated based on several sources:

- Detailed ramp metering operations strategies provided by Caltrans staff
- Traffic counts at specific on-ramps with operational ramp meters

- Freeway speed data measured by loop detectors from the Performance Monitoring System (PeMS)

For the I-580 corridor in the Dublin/Pleasanton area, peak period traffic counts had been collected for every freeway ramp during the spring of 2008. These traffic counts could be used to estimate the average hourly throughput on metered on-ramps.

For the I-880 corridor, Caltrans provided detailed ramp meter operational strategies. The strategies generally specify one to four different metering rates depending on conditions on the adjacent mainline freeway as measured by loop detectors. The freeway speed data from PeMS were evaluated in detail to determine the approximate percent of time during the peak period that each speed category would be in effect, and therefore which metering rate would be likely for the adjacent on-ramps. A weighted average of the various metering rates was applied for the analysis.

**Future Metering Rates.** Future traffic growth can cause conflicts between the need to increase or decrease ramp metering rates. Increases in congestion on the mainline freeway would tend to decrease the number of vehicles allowed through the on-ramp meters, if current operational strategies were left in place. However, increased traffic demand on on-ramps would tend to indicate a need to increase ramp metering rates to prevent long queues and blockages on local streets.

## 3.2 Transportation Network Updates for 2010, 2020 and 2040

The Alameda County Transportation Model update required revision to the existing input networks to define the road, transit and bike/pedestrian systems for each horizon year. The purpose of this section is to describe the various transportation networks updated or developed as part of the model update.

### 3.2.1 Roadway Networks

The current roadway networks in the Alameda Countywide model were relatively up to date and had only minor revisions to reflect 2010 conditions or to reflect projects assumed in the 2020 and proposed 2040 horizon years different from the existing model networks developed for the 2005, 2015 and 2035 horizon years. Project staff updated the networks to represent the base year 2010 for the model validation and to reflect future year 2020 and 2040 conditions. Networks also reflected the addition of nodes and centroid connectors based on any newly added traffic analysis zones (TAZs). Roadway network coding reflected existing and proposed express lane segments as identified in the RTP update. Included in this task were updated ramp metering assumptions included in the model, based on the information received from Caltrans in 2009. Ramp metering operational characteristics such as time of day operations, lanes and HOV bypass links were coded in the networks for the base year and future years.

The updated 2020 and 2040 roadway networks were based on the adopted Regional Transportation Plan constrained project list. Many of the projects in the constrained project list already exist in the 2020 and 2035 networks, however all projects listed in the RTP were verified for inclusion in the updated 2020 and 2040 networks. There were also areas that had local street improvements proposed for the future not identified in the RTP, and these were defined by the local jurisdictions to ensure they are coded. For areas located outside of Alameda County, only projects of regional significance, such as freeways, express lanes, expressways and major highways, were verified for review and coding, unless the roadways are located directly adjacent to Alameda County or served important corridors continuing into and out of Alameda County.

### 3.2.2 Transit Networks Coding

For the years 2010, 2020 and 2040, the transit networks have been updated in a similar manner as the roadway networks. The base year 2010 transit networks were actually coded to the most recent available timetables and route schedules, and as such more closely represent year 2012 and 2013 transit networks for the bus operators. However, these routes will be referred to as year 2010. Project staff updated all transit networks in Alameda County for the base year and forecast years 2020 and 2040. For the primary bus transit operators in Alameda County, including AC Transit, Union City Transit, Emery-go-round and LAVTA, proposed routing and frequency changes were provided by each operator and subsequently coded in the year 2020 and 2040 networks.

Year 2020 and 2040 transit networks included major capital projects as defined in the MTC Regional Transportation Plan (RTP), to the extent possible from existing information from the current Alameda Countywide model transit networks. As with the roadway improvements, for areas located outside of Alameda County, only projects of regional significance, such as BART extensions, commuter rail extensions and upgrades, light rail, ferry and bus rapid transit (BRT), have been coded into the transit networks based on coding information provided in the 2013 RTP transit networks, to ensure proper regional connectivity with Alameda County trip movements.

In addition to route itineraries and frequencies, transit coding also included adding transit nodes to reflect all bus and rail stops, park-and-ride facilities, shuttles to major employment sites not operated by public agencies, where data was available.

### 3.2.3 Existing and Future Bicycle Network Assumptions

Existing bicycle networks were developed from shapefiles maintained and collected by the Alameda CTC, shapefiles and local bicycle plan documents, and verification using Google maps. Bike lanes and routes were added as a new roadway link attribute for those roads that have these facilities. Bike paths were added as entirely new network links and nodes in the base networks, and followed shapes and contours in the bicycle network shapefiles so that distances can be coded accurately. Integration of the bicycle and roadway networks will allow for the use of model outputs, such as vehicle volumes, area type densities and speeds when refining the path parameters in the bicycle assignments.

Development of the future bicycle networks was more problematic since many future bicycle improvements are not well defined at an individual facility level to allow for detailed coding of bicycle infrastructure. Future bicycle infrastructure was based mostly from information gathered from adopted bicycle plans from the local jurisdictions and the Alameda CTC Countywide Bicycle Plan. Development of the 2040 bicycle network was done first, as this would represent the ultimate level of bicycle infrastructure, based on adopted county and local jurisdiction plans. The 2020 bicycle networks were then determined by using proximity to CBDs and major transit stops and stations. Future bicycle networks were developed using the following guidelines:

***2020:***

Bikeway segments were included in the 2020 network if they satisfied all of the following:

- Existing local and countywide network,
- Proposed local and countywide networks within urbanized areas based on adopted plans, and
- Proposed countywide network within CBDs or within one-half mile of transit.

***2040:***

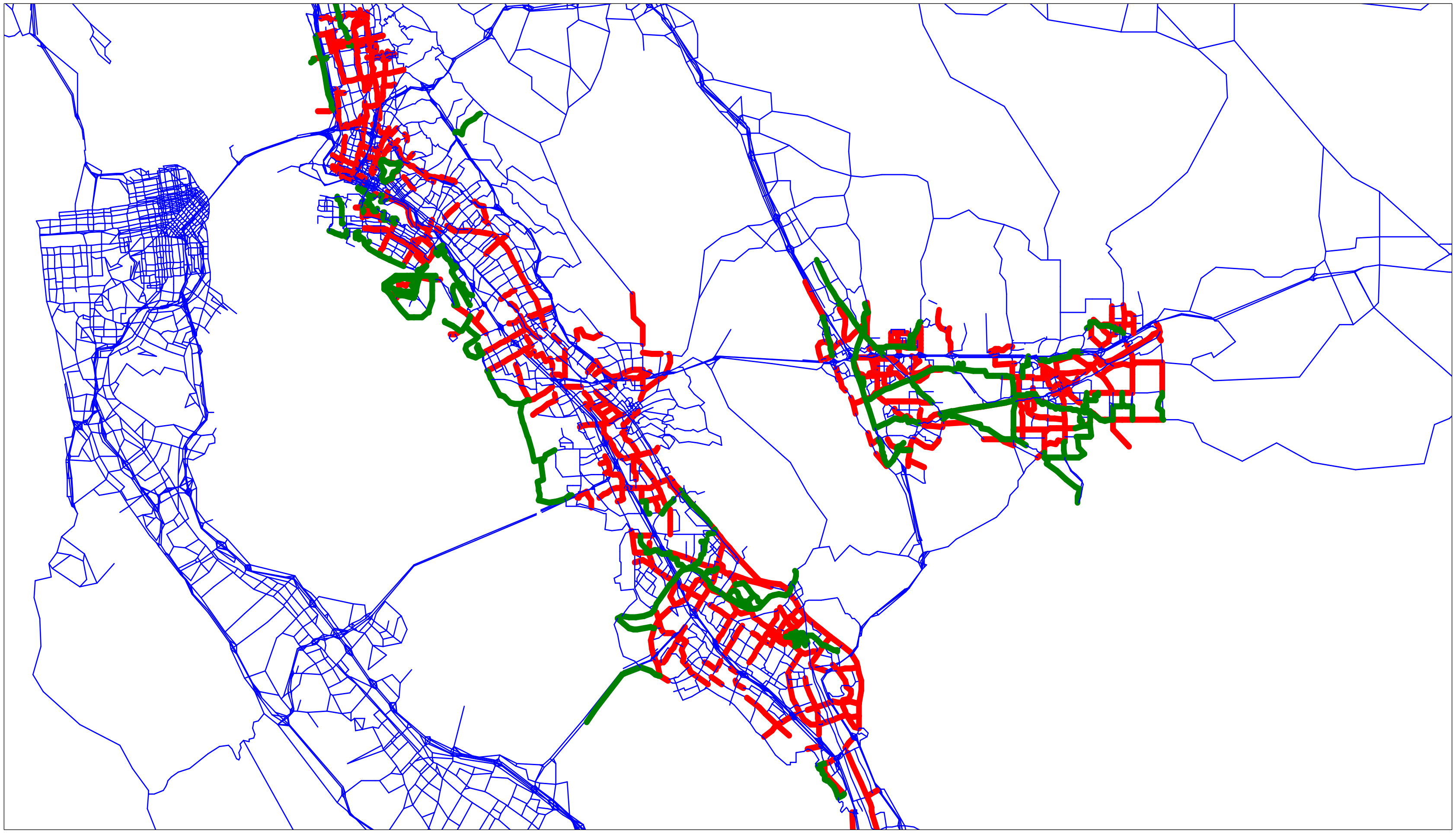
Bikeway segments were included in the 2040 network if they satisfied any of the following:

- Existing local and countywide network,
- 2020 network,
- Proposed local and countywide networks within urbanized areas based on adopted plans, and
- Three major inter-jurisdictional trails (Bay Trail, East Bay Greenway, and Iron Horse Trail).

Local bicycle/pedestrian coordinators were provided the opportunity to review the draft bicycle network based on email communication sent February 14, 2014. In all, only three jurisdictions provided substantive comments on the bicycle networks: Piedmont, Pleasanton and San Leandro. There was also a modification of an existing bikeway in North Berkeley/Albany (part of the East Bay Greenway) that was included as a year 2020 improvement. The comments were actually relatively minor in scope and were readily incorporated into the final bicycle networks.

Figures 3.1 through 3.4 show the final bicycle networks for Alameda County, highlighting the bike lanes and the separate bike paths/paved multi-use trails. The bicycle infrastructure appears actually quite well developed throughout Alameda County, even in the base year 2010. Future year 2020 improvements focus on locations near major transit stops and stations, including a combination of bike lanes and bike paths. The year 2040 improvements provide the local and more regional connections that bring together the 2020 improvements with completion of the Bay Trail, the Eastbay Greenway and the Iron Horse Trail. Table 3.2 summarizes the directional bike lane and bike path miles for each jurisdiction based on the model networks. Directional bike lanes miles will increase about 65 % from 2010 to 2040 and directional bike path miles will increase by about 96 % from 2010 to 2040.

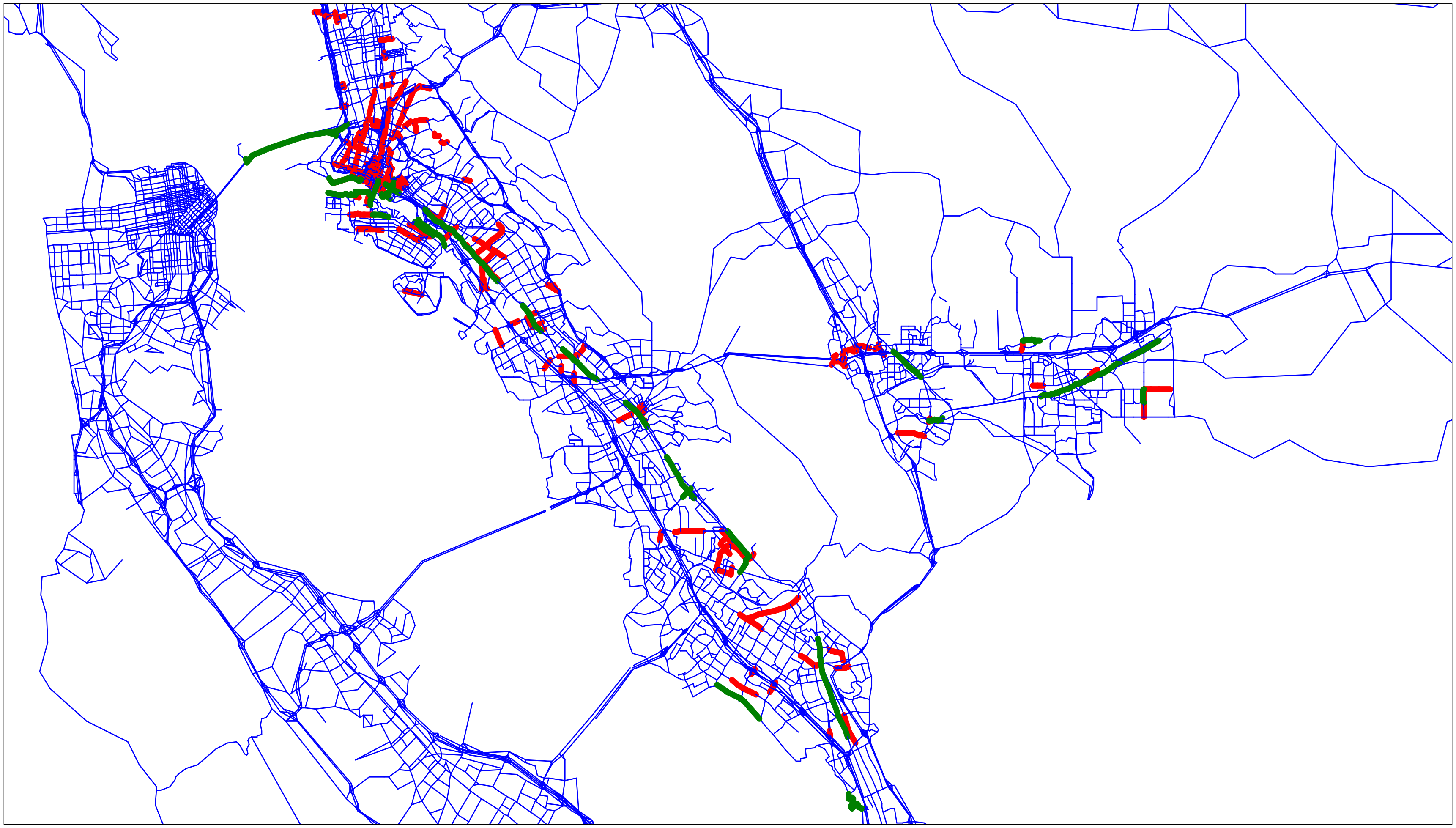
**Figure 3.1    2010 Bike Lane and Paths –Alameda County**



Bike Lanes

Bike Paths

**Figure 3.2 2020 Bike Lane and Path Improvements –Alameda County**



Bike Lanes

Bike Paths

**Figure 3.3 2040 Bike Lane and Path Improvements –Alameda County**

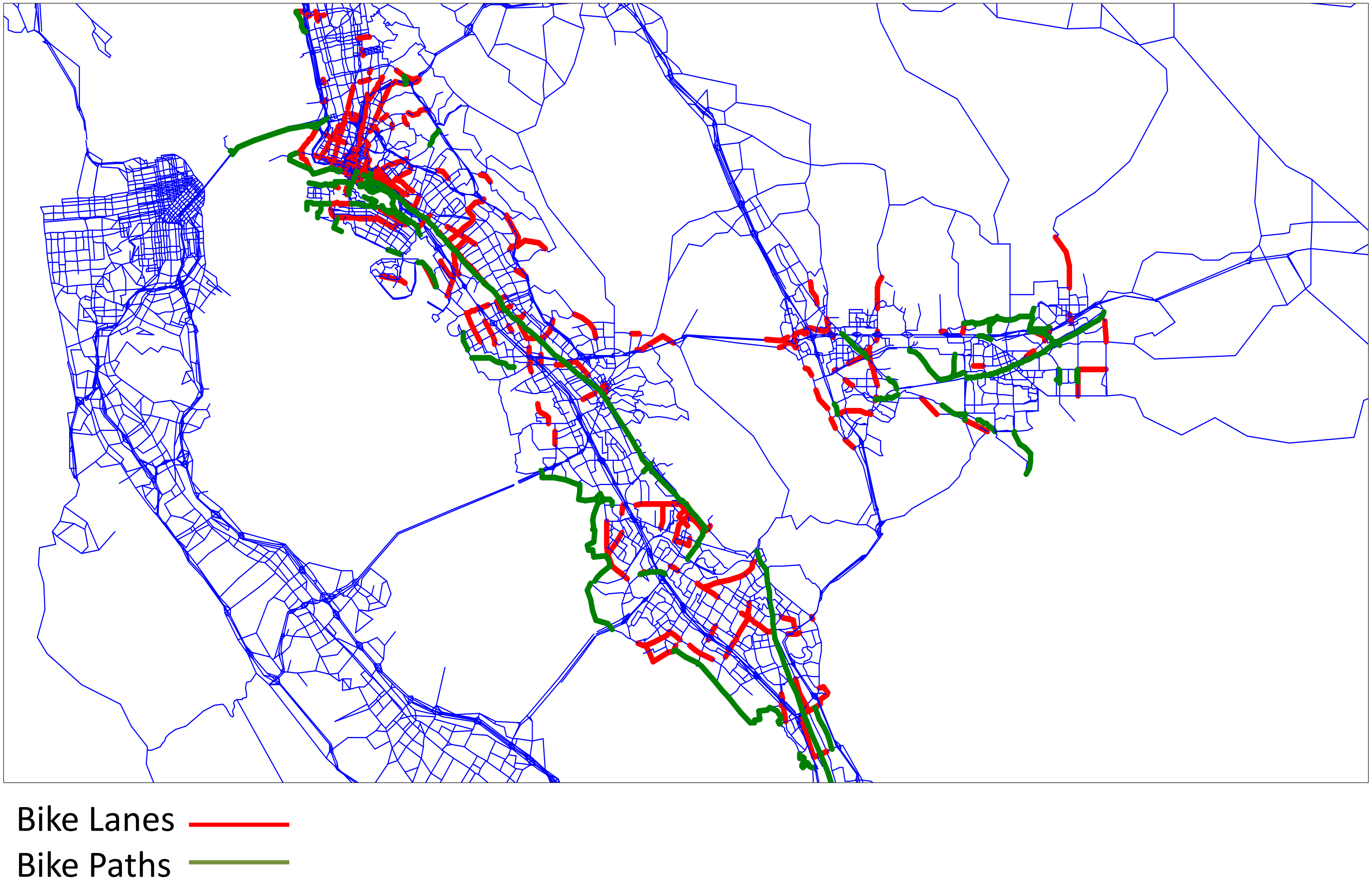
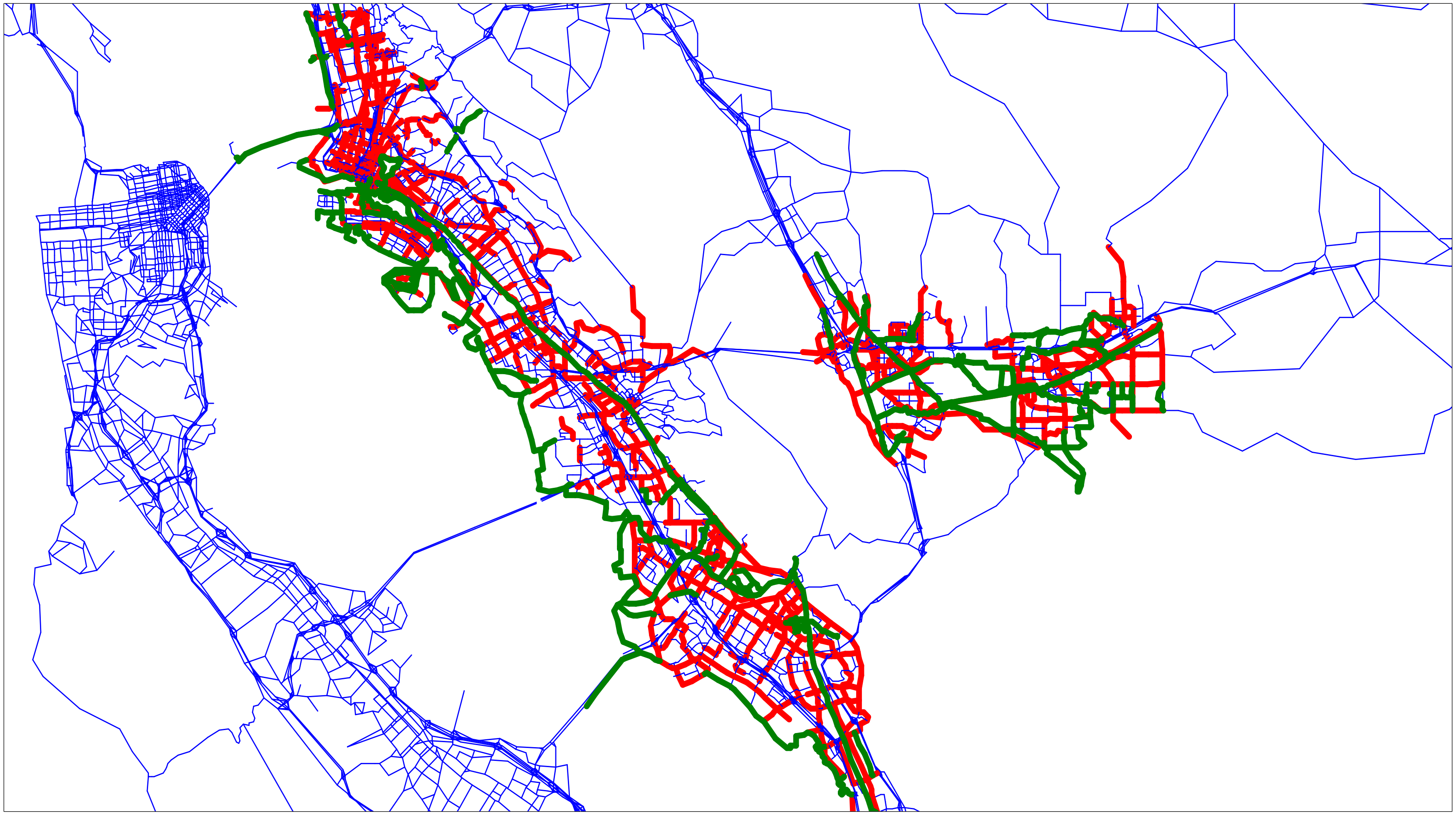


**Figure 3.4 2010, 2020 and 2040 Bike Lane and Paths –Alameda County**



Bike Lanes

Bike Paths

**Table 3.2 Bike Lane Infrastructure by Alameda County Jurisdiction**

| | Bike Lane Miles (Directional) | | | Bike Path Miles (Directional) | | |
|---|---|---|---|---|---|---|
| City | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Alameda | 27 | 39 | 56 | 38 | 47 | 66 |
| Albany | 2 | 4 | 6 | 0 | 2 | 5 |
| Berkeley | 41 | 43 | 45 | 41 | 42 | 44 |
| Dublin | 39 | 44 | 58 | 19 | 19 | 19 |
| Emeryville | 7 | 9 | 11 | 2 | 2 | 2 |
| Fremont | 123 | 138 | 172 | 49 | 59 | 99 |
| Hayward | 47 | 52 | 60 | 17 | 24 | 43 |
| Livermore | 98 | 103 | 117 | 37 | 50 | 74 |
| Newark | 17 | 21 | 32 | 1 | 5 | 10 |
| Oakland | 73 | 135 | 234 | 26 | 50 | 89 |
| Piedmont | 1 | 4 | 8 | 0 | 0 | 0 |
| Pleasanton | 57 | 62 | 81 | 32 | 34 | 41 |
| San Leandro | 32 | 37 | 52 | 10 | 14 | 27 |
| Union City | 28 | 40 | 64 | 12 | 16 | 34 |
| Uninc Alameda County | 48 | 51 | 72 | 27 | 29 | 56 |
| ALL | 640 | 782 | 1,068 | 311 | 393 | 609 |

# 4.0 Socioeconomic Data Update to ABAG Projections 2013 (Sustainable Community Strategies) for 2010, 2020 and 2040

As required by the Congestion Management Program legislation, as part of the Alameda CTC Model Update effort, the land use and socio-economic data used as inputs to the model were updated to reflect the latest projections developed by the Association of Bay Area Governments (ABAG). The database previously included in the Alameda CTC Model (Countywide Model) was based on ABAG's Projections 2009 and incorporated into the regional traffic analysis zones (RTAZ) used by the Metropolitan Transportation Commission (MTC) . The land use and socio-economic data were allocated to the Countywide Model TAZs, which are smaller than RTAZs, based upon review and redistribution by the jurisdictions in Alameda County. The Projections 2009 dataset contained data for the years 2000, 2005, 2020, and 2035.

In July 2013, ABAG and MTC jointly adopted the Plan Bay Area, which includes the Sustainable Communities Strategy (SCS), a plan that demonstrates how the region will meet its greenhouse gas reduction target through integrated land use, housing and transportation planning. As part of the current update, these SCS growth projections for the region were incorporated in the Countywide Model. The horizon years for the updated model are 2010, 2020, and 2040.

## 4.1 Input Databases

Three datasets served as inputs to the development of the new land-use and socio-economic data:

- SCS database (employment, population and households for all future years),
- US Census 2010 (population and households for 2010), and
- Distribution factors based on Projection 2009 data included in the existing Countywide Model, years 2005, 2015 and 2035.

The primary dataset is the most recent SCS projections as described above. ABAG provides forecasts of households and employment at the census tract level of details. This tract level forecast were converted to the 1,454 RTAZ level by MTC and ABAG. Because the employment data are in the North American Industry Classification System (NAICS) categories, project staff converted the employment data to the Standard Industrial Classification (SIC)-based categories used in the Countywide Model using a conversion provided by ABAG.

The Census 2010 dataset serves as the source of the household and population data for the base year 2010. Census blocks are typically smaller than the Countywide TAZs; therefore, households in Census blocks can be aggregated to TAZs used in the Countywide Model.

The Projections 2009 dataset developed in the previous Countywide Model Update provides another input. This dataset was used primarily to compute distribution factors to be applied to the SCS data for allocation of households and jobs from the larger RTAZs to the smaller TAZs.

### 4.2 Database Development for TAZs within Alameda County

The TAZs in Alameda County in the Countywide Model are smaller and more detailed than the MTC RTAZs. Therefore, the SCS data cannot be used directly as inputs to the Countywide Model and will need to be allocated to the smaller model TAZs. This section describes the methodologies adopted to develop the countywide TAZ level land-use data.

#### 4.2.1 Base Year 2010 Database for TAZ 1580 system

**Household and Population Data.** To develop the countywide TAZ-level household and population data for the year 2010, households and household related data (such as population) were developed for the TAZ 1580 system based on proportioning the RTAZ data using 2010 Census block data. Using the geographic relationship between RTAZs, TAZ1580 and Census blocks, total households and population in each new TAZ will be disaggregated from the RTAZs.

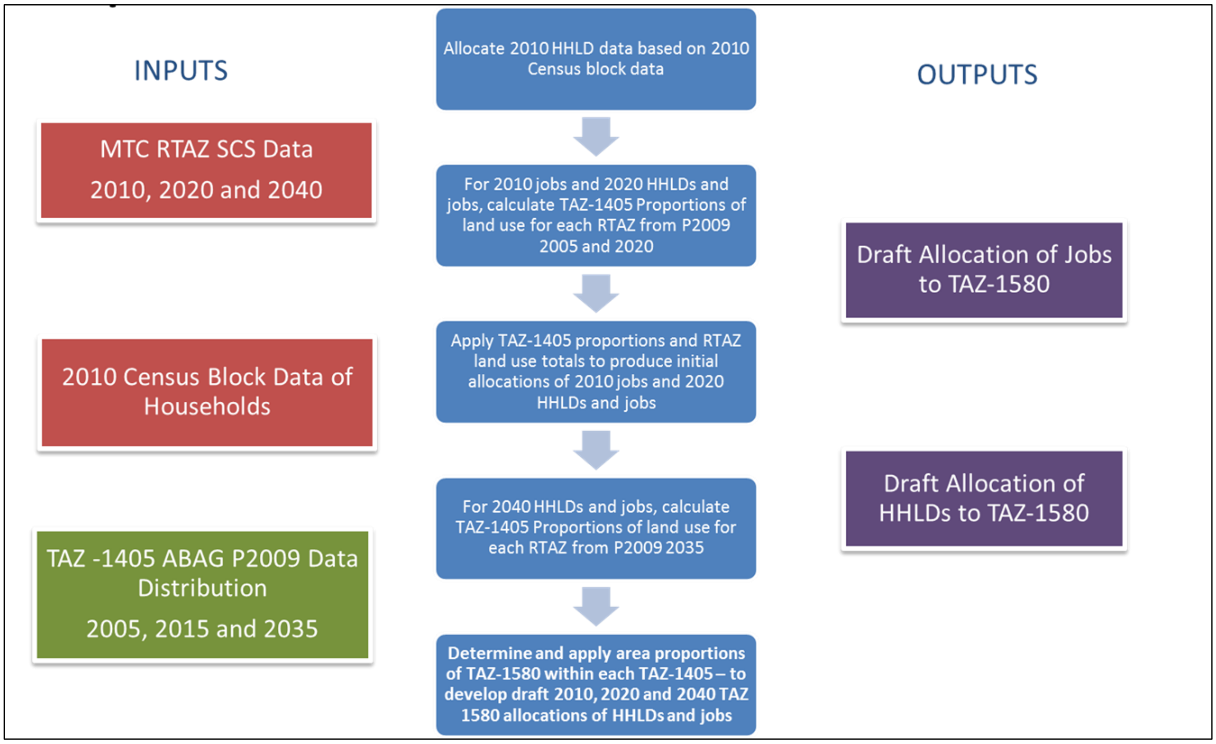
**Employment Data.** Since Census 2010 does not contain the type of employment information needed by the Countywide Model, the SCS dataset is the best available source for 2010 employment information. The SCS data was disaggregated from the RTAZ level to the smaller county model TAZ level for use in the model. Employment allocations from the Projections 2009 data used in previous Countywide Model Update were used to develop an allocation scheme. The Projections 2009 data included in the model distributed at the countywide model TAZs were based on review and input from the local jurisdictions, and therefore, this dataset (proportions) reflects future development patterns envisioned by local jurisdictions and provides a good starting point for a new allocation.

The resulting allocation methodology was used to disaggregate the RTAZ households, population, and employment first to the previous Countywide Model TAZ system (the current 2013 update added 175 TAZs within Alameda County to the existing 1,405 TAZs, "existing 1405 TAZs"). The following steps describe the methodology, shown on Figure 4.1 that was used to allocate base year 2010 employment within Alameda County:

1. Compile SCS land uses for each RTAZ.
2. Use existing correspondence lists to determine which Alameda TAZs are within each RTAZ.
3. For each RTAZ, use the Projections 2009 data for the year 2005 to determine the percentage of each land-use in the smaller county TAZs.
4. Apply the percentages computed above to the SCS totals for each RTAZ. For example, if TAZ 1025 is in RTAZ 920 and TAZ 1025 contained 30 percent of the retail employment in RTAZ 920 in 2005 according to the final Projections 2009 dataset, then 30 percent of the SCS retail jobs from RTAZ 920 are in TAZ 1025. If RTAZ 920 had 1,000 retail jobs in 2010 according to SCS, TAZ 1025 would then be assigned 300 (30 percent of 1,000) retail jobs.

The result of the above computations would be applied to the SCS 2010 employment data at the existing TAZ 1405 level to develop the 2010 employment database.

**Figure 4.1 Land Use Allocation Process**



### 4.2.2 Future Years 2020 and 2040 Database for TAZ 1580 system

**Employment, Future Households, and Population Data for TAZ 1580 System.** For future year 2020 and 2040 data, the allocation process was similar to the steps taken for developing the allocations of base year 2010 employment data. For each RTAZ, the Projections 2009 distribution factors was used to allocate data from the RTAZs to the TAZ 1405 level. For the year 2020 and 2040, the Projections 2009 distribution factors from the year 2020 and 2035 were used to allocate the 2020 and 2040 RTAZ level data.

Because 175 zones were recently added to the Countywide Model TAZ system, further disaggregation of all data for all years is needed to distribute the land use data to the newly added zones from the existing TAZ 1405 level to the updated 1580 TAZ system. If a TAZ has not been split recently, then the preliminary allocation of employment would be completed at this point. For the newly added TAZs, the draft distribution based on an “area ratio”, or land proportion, where the land area of the new TAZ will be compared to the land area of the “parent TAZ” from which it is split and the resulting area ratio would then be applied to the land use totals for the “parent TAZ’. The underlying assumption is that employment in each TAZ is approximately proportional to the size of the zone.

The following methodology was applied to further distribute the data in to the newly added TAZs. :

- For each TAZ that was split, use ArcGIS (a widely-used Geographic Information System software) to determine the land area of the zone before the split and the area of the new zones after the split. Calculate the area ratio between the new zones and the “parent zones”. The area ratio serves as a proxy for the share of employment in each TAZ.

Completion of these steps would generate a preliminary estimate of households, population, and employment at the most current TAZ 1580 level, which would later be provided to the local jurisdictions for their review and feedback. Figure 4.1 illustrates the complete process of allocating the SCS data into the countywide model TAZs 1580 system (it focuses only on households and employment data since review of local jurisdictions is requested only for housing and employment data). Adjustments to the estimates were made according to the feedback before the land-use datasets are finalized. To satisfy the ABAG/MTC consistency requirements, the final countywide totals have to stay within one percent variation from the SCS totals.

**Database for Buffer Areas outside Alameda County.** There are several areas outside but adjacent to Alameda County where the County Model TAZs are smaller than the RTAZs. These areas include El Cerrito in west Contra Costa County and Milpitas in north Santa Clara County and are referred to as the buffer areas for the model. The land-use and socio-economic database for the buffer areas will be developed using the same allocation methodology applied for County Model TAZs within Alameda County.

**Database for Areas outside Alameda County and outside the Buffer Areas.** The Alameda Countywide Model directly uses the MTC RTAZ system outside of Alameda County and the buffer areas. There is a one-to-one correspondence between county TAZs and RTAZs and therefore, no subarea allocations are required. The SCS inputs at the RTAZ level were used directly without modifications. However, the SCS dataset does not include San Joaquin County, which is an external area in the Alameda Countywide Model. Since the last update of the Alameda Countywide Model, San Joaquin County has adopted an updated land-use dataset, as part of the San Joaquin Regional Plan 2011. This updated dataset was incorporated in the Alameda CTC model.

### 4.3 Information Distributed to the Jurisdictions for Review

Upon developing the draft allocation for employment, households and population data for base year 2010 and future years 2020 and 2040, the database was distributed to the jurisdictions for their review and reallocation along with other supportive materials to facilitate the review process. To be in conformance with the regional model consistency requirements, the jurisdictions were required to be within plus or minus one percent of the SCS control totals for employment and households at the jurisdiction level. The following were distributed to the local jurisdictions for review:

- Employment – Data for all three years (2010, 2020 and 2040) in updated county TAZs with corresponding RTAZs identified. The spreadsheets will also include P2009 land use for years 2005 and 2020, and 2012 CWTP land use for 2035 in the previous TAZ system for reference.
- Households – Similar to employment data, households data for all three years in the updated county TAZs will be provided along with the existing data.
- TAZ maps – PDF and GIS format.

Based on local jurisdiction review, the draft allocations were subsequently refined and new TAZ allocations were prepared. The summary of the final allocations of households and jobs for 2010, 2020 and 2040 are summarized in Tables 4.1.

**Table 4.1 2010, 2020, and 2040 TAZ Allocations of Households and Jobs**

| Jurisdiction | 2010 Households | 2010 Jobs | 2020 Households | 2020 Jobs | 2040 Households | 2040 Jobs |
|---|---|---|---|---|---|---|
| Alameda | 30,173 | 24,376 | 32,433 | 29,398 | 36,660 | 34,642 |
| Alameda County | 45,666 | 22,339 | 47,274 | 30,020 | 50,574 | 34,498 |
| Albany | 7,411 | 4,345 | 7,879 | 4,747 | 8,746 | 5,747 |
| Berkeley | 46,168 | 77,546 | 49,488 | 86,827 | 56,126 | 100,416 |
| Dublin | 15,059 | 16,963 | 18,805 | 23,911 | 25,615 | 33,103 |
| Emeryville | 5,704 | 16,358 | 7,675 | 20,082 | 11,635 | 23,778 |
| Fremont | 71,123 | 86,604 | 77,063 | 108,240 | 90,875 | 127,319 |
| Hayward | 46,888 | 68,919 | 52,095 | 78,481 | 60,625 | 87,065 |
| Livermore | 29,432 | 48,164 | 34,322 | 58,232 | 40,935 | 67,107 |
| Newark | 13,018 | 16,798 | 14,362 | 21,151 | 17,521 | 23,306 |
| Oakland * | 154,068 | 189,058 | 175,268 | 238,303 | 212,065 | 280,493 |
| Piedmont | 3,821 | 2,045 | 3,871 | 2,102 | 3,919 | 2,425 |
| Pleasanton | 25,808 | 55,787 | 28,198 | 66,070 | 33,152 | 74,775 |
| San Leandro | 31,472 | 39,671 | 34,019 | 47,137 | 39,075 | 51,746 |
| Union City | 20,433 | 17,193 | 21,895 | 22,577 | 23,925 | 26,216 |
| TOTAL | 546,244 | 686,166 | 604,647 | 837,278 | 711,448 | 972,636 |

### 4.4 Socioeconomic Inputs for San Joaquin County

The Alameda Countywide Model used the households and employment inputs from San Joaquin Council of Governments' 2011 RTP, which was the most recently adopted database available during the model development process. Table 4.2 shows these inputs for 2010, 2020, and 2040.

**Table 4.2 San Joaquin County - 2010, 2020, and 2040 Households and Jobs**

| | Households | Employment |
|---|---|---|
| 2010 | 221,184 | 202,064 |
| 2020 | 252,931 | 233,778 |
| 2040 | 316,429 | 297,201 |

# 5.0 Model Calibration

Model calibration is the process by which the model equations are applied using the input networks, socioeconomic data and pricing assumptions, the model estimates are then compared to observed data, and the model parameters are adjusted so that the model results more accurately compare to observed data.

### 5.1 Calibration Data

The starting point for calibration was to obtain year 2000 observed data. The primary sources of data used to calibrate the trip distribution models were from the 2000 Census Transportation Planning Package (CTPP) for home-based work trips and the MTC 2000 Regional Bay Area Transportation Survey (BATS) for both work and non-work trips. Specifically, the CTPP data was used to generate commuter trips by County-to-County flow and to stratify trips by income quartile, and the MTC 2000 BATS data was used to develop County-to-County trip flows for non-work trips. The primary data sets available for model calibration included the following:

- Year 2000 households by number of workers and auto ownership from Census data,
- Year 2000 Journey to Work County-to-County worker flows from 2000 Census,
- Year 2000 Journey to Work by mode of travel, County-level and regional-level from Census,
- MTC Year 2000 Home Interview Survey data, including:
  - County to County home-based work person trips,
  - County to County non-work person trips, and
  - Average trip length by trip purpose,
- Year 2000 mode choice calibration targets, as base estimates for transit submode shares, developed by VTA as part of the FTA New Starts model calibration, and
- BART 1998 and 2008 System Survey data for BART submode estimates for walk-access, park-and-ride and kiss-and-ride.

### 5.2 Workers per Household and Auto Ownership Models

The model that estimates the number of workers and number of autos per household (WHHAOWN) is the first model to be recalibrated as part of the Alameda Countywide Model update project. The WHHAOWN models generate critical inputs to subsequent models in the four-step modeling chain[1,] as the number of workers in each household and auto ownership are important characteristics that influence travel demand and choices. The base year calibration methodology agreed to by the Travel Demand Model Task Force was to recalibrate the Alameda Countywide models to a year 2000 base, using data from the 2000 census and 2000 MTC Regional Household Travel Surveys since the 2010 household survey results were not available in a format that could be used for the model calibration prior to the project completion.

[1] The four steps in the Alameda Countywide trip-based models are generation, distribution, mode choice and assignment.

### 5.2.1 Description of the MTC BAYCAST-90 Workers per Household/Auto Ownership Model

The workers and autos per household model (WHHAOWN) used by the Alameda Countywide Model is a nested logit choice model applied at the zone-of-residence level. This model was estimated by MTC as part of the BAYCAST-90 model version. The inputs to the WHHAOWN model are the number of households stratified by household income quartile level. Variables in this choice model include mean household income, mean household size, the share of households residing in multi-family dwelling units, the share of persons age 62-or-older, and gross population density. Coefficients for the WHHAOWN choice model are shown in Table 5.1B. A detailed definition of the variables used in the WHHAOWN models is included in Table 5.1A.

The nested structure for the WHHAOWN model is shown in Figure 5.1. The upper level nest of this model splits households into households by workers in household level (0, 1, 2+ workers per household). The lower nest further splits these households by auto ownership level (0, 1, 2+ vehicles per household). The output from this WHHAOWN model is the number of households by household income quartile (4) by workers in household level (3) by auto ownership level (3) or 36 different market segments per travel analysis zone.

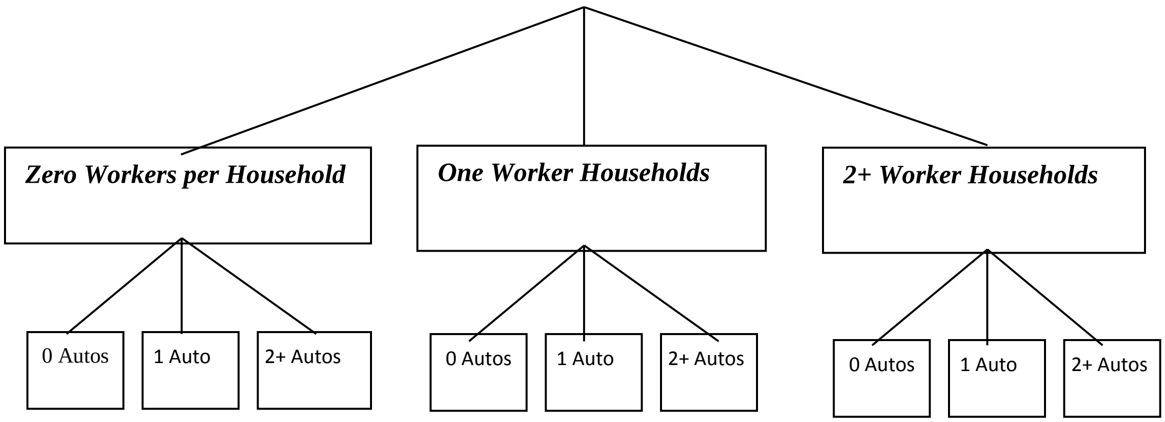
**Table 5.1A Definition of the Variables Used in the Workers and Autos per Household Model**

| Variable Name | Model(s) | Definition |
|---|---|---|
| Constant | Multiple | Modal or Utility intercept. |
| GPOPD-Leg 1 | WHHAOWN | Gross Population Density (TOTPOP/TOTACRE), MIN(10.0,GPOPD) |
| GPOPD-Leg 2 | WHHAOWN | Gross Population Density (TOTPOP/TOTACRE), MAX(0,MIN((GPOPD-10.0),20.0)) |
| GPOPD-Leg 3 | WHHAOWN | Gross Population Density (TOTPOP/TOTACRE), MAX(GPOPD-30.0) |
| HH Size | WHHAOWN | Persons per Household (same as Pers/HH) |
| Income-Leg 1 | Multiple | Income in 1989 dollars. MIN(Income,25000) |
| Income-Leg 2 | Multiple | Income in 1989 dollars. MAX(0,MIN(Income-25000),50000)) |
| MFDU | WHHAOWN | Multi-Family Dwelling Unit Dummy Variable |
| PHH | Multiple | Persons per Household (same as Pers/HH) |
| SHPOP62+ | WHHAOWN | Share of Population Age 62+ |
| Stanfordj | Multiple | Stanford zones, zone of attraction (zones=244, 249-252) |
| TOTACRE | Multiple | Total Acres (ABAG Land Use) |
| Veh/HH | Multiple | Vehicles Available per Household (same as VHH) |
| VHH | Multiple | Vehicles Available per Household (same as Veh/HH) |
| THACC0 | WHHAOWN | Employment by Transit/Highway Accessibility Measure – Zero Auto Households |
| THACC1 | WHHAOWN | Employment by Transit/Highway Accessibility Measure – One Auto Households |

## Table 5.1B Workers Per Household and Auto Ownership Model Coefficients

| WHH=0 | | | WHH=1 | | | WHH=2 | | | Variable | Model #9W (Nested) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AO=0 | AO=1 | AO=2 | AO=0 | AO=1 | AO=2 | AO=0 | AO=1 | AO=2 | | Beta | t-stat |
| X | | | | | | | | | Constant 1 | 1.615 | (1.4) |
| | X | | | | | | | | Constant 2 | 3.084 | (2.6) |
| | | X | | | | | | | Constant 3 | 1.679 | (1.4) |
| | | | X | | | | | | Constant 4 | 1.586 | (1.2) |
| | | | | X | | | | | Constant 5 | 3.284 | (2.5) |
| | | | | | X | | | | Constant 6 | 1.237 | (0.9) |
| | | | | | | X | | | Constant 7 | -2.941 | (2.8) |
| | | | | | | | X | | Constant 8 | -0.7834 | (1.1) |
| | X | | | | | | | | Income Leg1 | 3.956E-02 | (2.1) |
| | | X | | | | | | | Income Leg1 | 0.0888 | (3.6) |
| | | | X | | | | | | Income Leg1 | 0.2853 | (2.4) |
| | | | | X | | | | | Income Leg1 | 0.3433 | (3.0) |
| | | | | | X | | | | Income Leg1 | 0.3907 | (3.3) |
| | | | | | | X | | | Income Leg1 | 0.9325 | (1.7) |
| | | | | | | | X | | Income Leg1 | 0.9719 | (1.8) |
| | | | | | | | | X | Income Leg1 | 1.0320 | (1.9) |
| | X | | | | | | | | Income Leg2 | 9.989E-03 | (0.6) |
| | | X | | | | | | | Income Leg2 | 2.268E-02 | (1.4) |
| | | | X | | | | | | Income Leg2 | 4.776E-02 | (1.4) |
| | | | | X | | | | | Income Leg2 | 5.624E-02 | (1.7) |
| | | | | | X | | | | Income Leg2 | 7.682E-02 | (2.4) |
| | | | | | | X | | | Income Leg2 | 0.2699 | (1.6) |
| | | | | | | | X | | Income Leg2 | 0.2866 | (1.7) |
| | | | | | | | | X | Income Leg2 | 0.3048 | (1.8) |
| | | X | | | | | | | HH Size | 0.3311 | (3.8) |
| | | | | | X | | | | HH Size | 0.5986 | (8.9) |
| | | | | | | X | X | X | HH Size | 1.3790 | (2.4) |
| X | | | X | | | X | | | MFDU | 0.5662 | (3.0) |
| | | X | | | X | | | X | MFDU | -1.0700 | (8.8) |
| X | X | X | | | | | | | SHPOP 62+ | 4.5390 | (2.9) |
| | | | | | | X | X | X | SHPOP 62+ | -12.1900 | (1.7) |
| | X | | | X | | | X | | GPOPD -Leg1 | -0.05354 | (1.6) |
| | | X | | | X | | | X | GPOPD -Leg1 | -0.07401 | (2.2) |
| | X | | | X | | | X | | GPOPD -Leg2 | -0.04987 | (3.6) |
| | | X | | | X | | | X | GPOPD -Leg2 | -0.11170 | (6.9) |
| | X | | | X | | | X | | GPOPD -Leg3 | -2.506E-02 | (4.1) |
| | | X | | | X | | | X | GPOPD -Leg3 | -2.724E-02 | (2.9) |
| X | X | X | | | | | | | Theta-NWHH | 0.7451 | (3.0) |
| X | | | X | | | X | | | THACC0 | 4.732 | NA |
| | X | | | X | | | X | | THACC1 | 2.361 | NA |
| | | | X | X | X | | | | Theta-SWHH | 0.4477 | (2.7) |
| | | | | | | X | X | X | Theta-MWHH | 0.1968 | (1.8) |

**Figure 5.1 Workers and Vehicles by Household Submodel Structure**




### 5.2.2 Update to the Existing Workers per Household /Auto Ownership Model

The existing WHHAOWN models were updated to include a dynamic representation of the employment accessibility measure that is used as an explanatory variable for predicting auto ownership level. This variable is essentially a measure of the number of jobs available by a unit of transit time divided by the number of jobs available by the same unit of highway time applied at the zone of residence, and is used in the zero and one auto ownership choice. A value greater than one means that more jobs are accessible by transit relative to highway within a given unit of time. Most TAZs have values much less than 1.0, however, TAZs in areas with high levels of transit service have values of up to 1.8 in the base year 2000. In the existing WHHAOWN models, this value was hard coded for each TAZ and would not vary based on changes to either transit or highway infrastructure. A process was added to calculate the accessibility measure based on network characteristics from the coded transit and highway networks. All other application procedures remain unchanged from the existing WHHAOWN models.

### 5.2.3 Calibration Results

The WHHAOWN model equations are calibrated to match observed characteristics from year 2000 Census Transportation Planning Package (CTPP) data. Data from the 2000 CTPP can be tabulated to produce the number of households classified by the number of workers and the number of automobiles owned, and this data is summarized for each County in the 9-County MTC model region. The model is calibrated to nine cell values for each County (three worker classifications by three auto ownership classifications) by adjusting constants applied to each cell until the model estimates can adequately match observed totals. Each cell value was calibrated to within 1 percent error for each County. During the course of model calibration, the adjusted constants were reviewed to ensure that overly large constants were not estimated. Large constants overwhelm the model utility equations, effectively negating the effect that the individual variables would have on the probability calculations. The results of the model calibration that compares observed to modeled households by each cell are shown in Table 5.2, including the ratio of modeled to observed values. The final model constants are shown in Table 5.3. Overall, the model constants are not overly large (values greater than 4 or less than -4 are a typical rule of thumb for constants outside the range of acceptance) and show reasonable trends within each group.

## Table 5.2 Workers per Household and Auto Ownership Calibration Results

| Observed | Zero Worker Households | | | One Worker Households | | | Two + Worker Households | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | 0 Autos | 1 Auto | 2+ Autos | 0 Autos | 1 Auto | 2+ Autos | 0 Autos | 1 Auto | 2+ Autos | Households | Workers |
| San Francisco | 41,940 | 30,080 | 9,855 | 36,090 | 70,040 | 24,565 | 15,625 | 38,320 | 63,330 | 329,845 | 423,883 |
| San Mateo | 8,640 | 25,780 | 19,900 | 4,075 | 41,995 | 44,195 | 2,645 | 13,065 | 93,935 | 254,230 | 364,378 |
| Santa Clara | 16,415 | 44,170 | 40,190 | 9,075 | 93,695 | 111,670 | 6,230 | 25,690 | 219,350 | 566,485 | 842,615 |
| Alameda | 30,935 | 53,910 | 34,805 | 18,425 | 97,485 | 84,155 | 7,465 | 30,710 | 165,895 | 523,785 | 710,240 |
| Contra Costa | 13,220 | 36,140 | 28,685 | 6,110 | 53,900 | 69,380 | 2,910 | 14,275 | 119,810 | 344,430 | 471,878 |
| Solano | 4,835 | 13,015 | 10,940 | 2,395 | 18,960 | 25,460 | 1,300 | 5,725 | 47,810 | 130,440 | 183,903 |
| Napa | 1,905 | 5,970 | 4,215 | 610 | 6,630 | 8,725 | 290 | 2,050 | 15,015 | 45,410 | 59,353 |
| Sonoma | 6,220 | 20,660 | 15,165 | 2,135 | 27,045 | 32,235 | 1,540 | 6,685 | 60,995 | 172,680 | 234,465 |
| Marin | 2,970 | 11,115 | 8,095 | 1,265 | 19,215 | 20,310 | 780 | 4,750 | 32,245 | 100,745 | 135,228 |
| All | 127,080 | 240,840 | 171,850 | 80,180 | 428,965 | 420,695 | 38,785 | 141,270 | 818,385 | 2,468,050 | 3,425,940 |

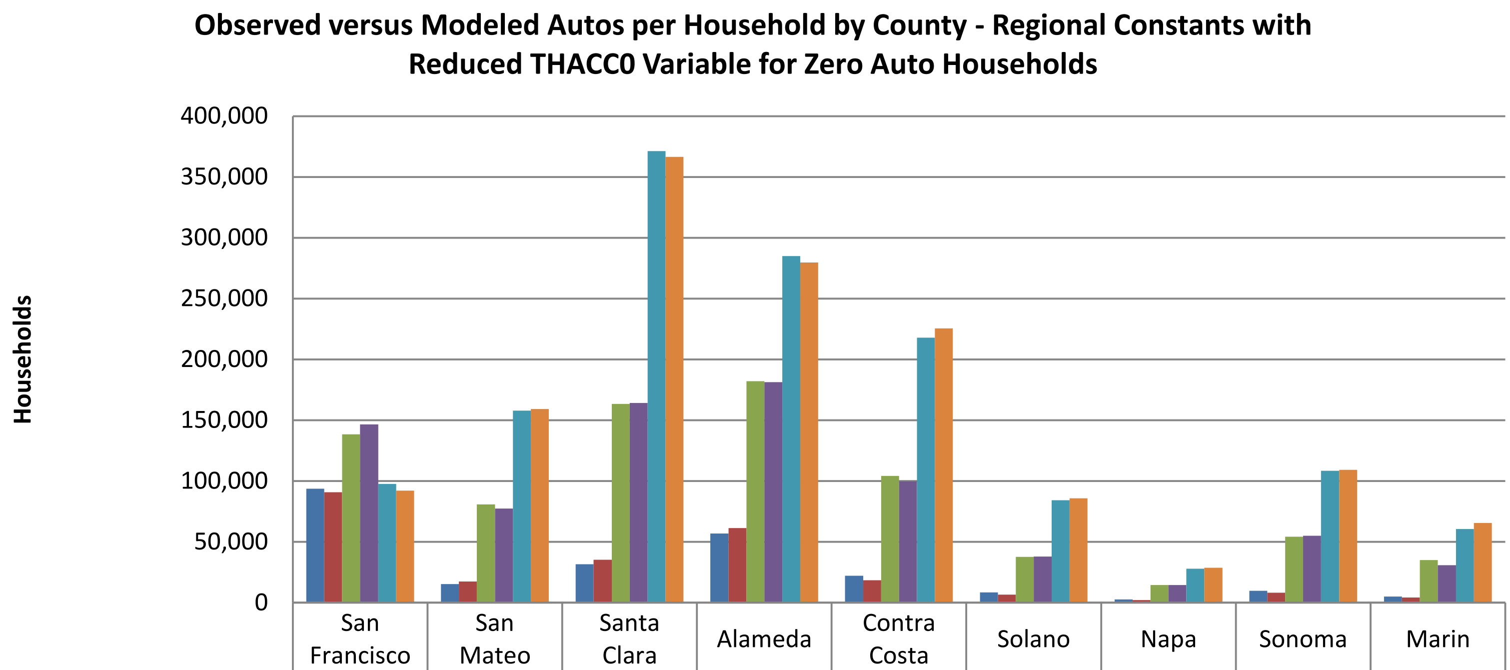
| Modeled | Zero Worker Households | | | One Worker Households | | | Two + Worker Households | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | 0 Autos | 1 Auto | 2+ Autos | 0 Autos | 1 Auto | 2+ Autos | 0 Autos | 1 Auto | 2+ Autos | Households | Workers |
| San Francisco | 47,088 | 36,822 | 6,505 | 26,983 | 70,785 | 18,416 | 16,863 | 39,013 | 67,177 | 329,652 | 423,817 |
| San Mateo | 8,269 | 21,638 | 18,106 | 6,205 | 42,559 | 46,946 | 2,890 | 13,298 | 94,146 | 254,057 | 371,545 |
| Santa Clara | 16,515 | 43,440 | 35,286 | 12,628 | 89,486 | 104,046 | 6,092 | 31,238 | 227,083 | 565,814 | 867,193 |
| Alameda | 31,732 | 53,527 | 29,179 | 20,658 | 96,489 | 79,950 | 9,005 | 31,267 | 170,693 | 522,500 | 724,510 |
| Contra Costa | 10,233 | 33,780 | 31,985 | 6,199 | 53,630 | 72,898 | 2,062 | 12,337 | 120,732 | 343,856 | 470,555 |
| Solano | 3,709 | 13,123 | 13,065 | 2,242 | 20,548 | 29,337 | 602 | 4,374 | 43,386 | 130,386 | 173,032 |
| Napa | 1,382 | 5,768 | 5,830 | 715 | 7,479 | 9,957 | 151 | 1,236 | 12,869 | 45,387 | 53,791 |
| Sonoma | 4,895 | 20,850 | 20,935 | 2,715 | 29,122 | 37,180 | 627 | 5,012 | 51,040 | 172,376 | 210,715 |
| Marin | 2,522 | 10,666 | 10,220 | 1,423 | 17,084 | 20,656 | 328 | 3,062 | 34,686 | 100,647 | 134,353 |
| All | 126,345 | 239,614 | 171,111 | 79,768 | 427,182 | 419,386 | 38,620 | 140,837 | 821,812 | 2,464,675 | 3,429,509 |

| Modeled/Observed | Zero Worker Households | | | One Worker Households | | | Two + Worker Households | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **County** | **0 Autos** | **1 Auto** | **2+ Autos** | **0 Autos** | **1 Auto** | **2+ Autos** | **0 Autos** | **1 Auto** | **2+ Autos** | **Households** | **Workers** |
| **San Francisco** | 1.12 | 1.22 | 0.66 | 0.75 | 1.01 | 0.75 | 1.08 | 1.02 | 1.06 | 1.00 | 1.00 |
| **San Mateo** | 0.96 | 0.84 | 0.91 | 1.52 | 1.01 | 1.06 | 1.09 | 1.02 | 1.00 | 1.00 | 1.02 |
| **Santa Clara** | 1.01 | 0.98 | 0.88 | 1.39 | 0.96 | 0.93 | 0.98 | 1.22 | 1.04 | 1.00 | 1.03 |
| **Alameda** | 1.03 | 0.99 | 0.84 | 1.12 | 0.99 | 0.95 | 1.21 | 1.02 | 1.03 | 1.00 | 1.02 |
| **Contra Costa** | 0.77 | 0.93 | 1.12 | 1.01 | 0.99 | 1.05 | 0.71 | 0.86 | 1.01 | 1.00 | 1.00 |
| **Solano** | 0.77 | 1.01 | 1.19 | 0.94 | 1.08 | 1.15 | 0.46 | 0.76 | 0.91 | 1.00 | 0.94 |
| **Napa** | 0.73 | 0.97 | 1.38 | 1.17 | 1.13 | 1.14 | 0.52 | 0.60 | 0.86 | 1.00 | 0.91 |
| **Sonoma** | 0.79 | 1.01 | 1.38 | 1.27 | 1.08 | 1.15 | 0.41 | 0.75 | 0.84 | 1.00 | 0.90 |
| **Marin** | 0.85 | 0.96 | 1.26 | 1.12 | 0.89 | 1.02 | 0.42 | 0.64 | 1.08 | 1.00 | 0.99 |
| **All** | 0.99 | 0.99 | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## Table 5.3 Final Calibration Constants

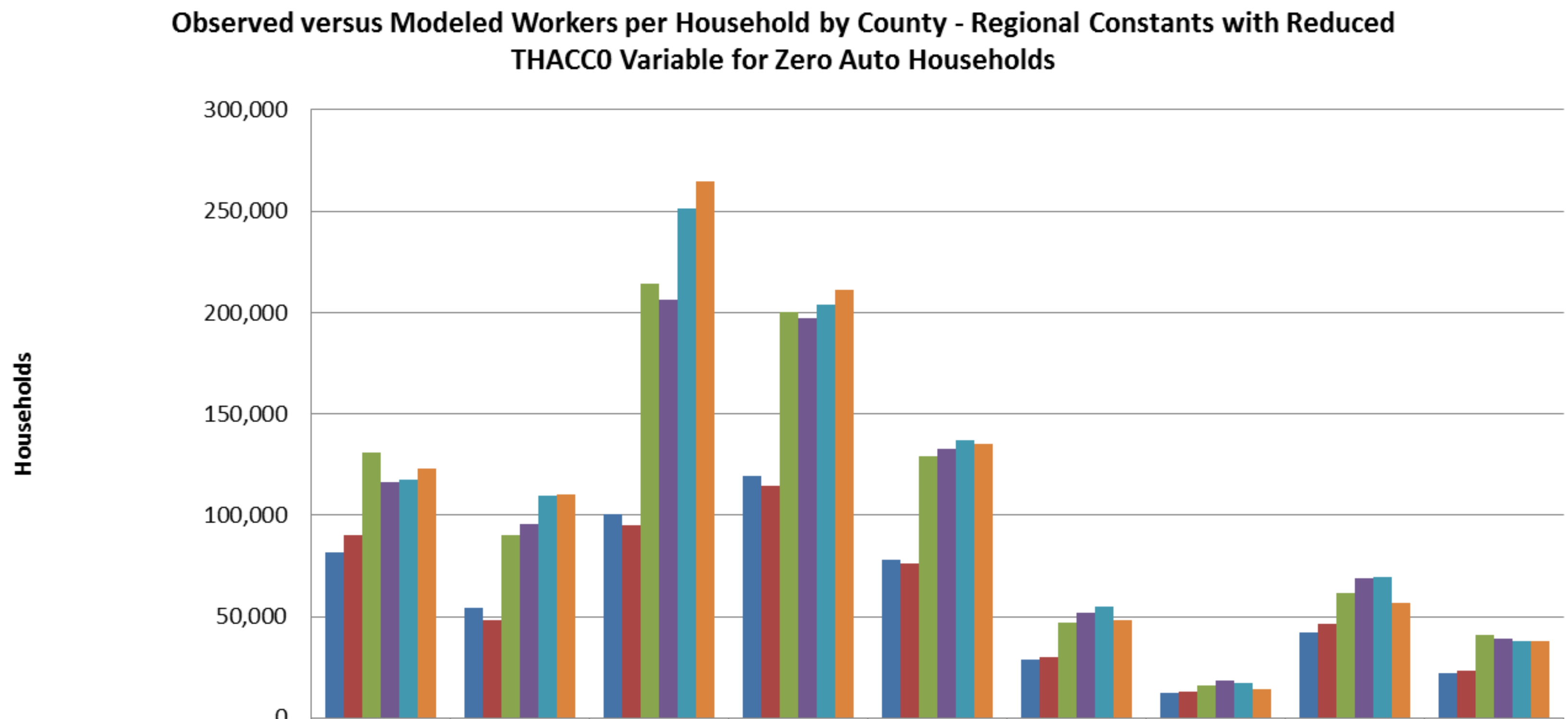
| Zero Worker Households | | | One Worker Households | | | Two + Worker Households | | |
|---|---|---|---|---|---|---|---|---|
| **0 Autos** | **1 Auto** | **2+ Autos** | **0 Autos** | **1 Auto** | **2+ Autos** | **0 Autos** | **1 Auto** | **2+ Autos** |
| 2.0109 | 1.7322 | 1.8069 | 1.4574 | 1.4003 | 1.0638 | 0.6667 | -0.0271 | 0 |

**Figure 5.2**




| | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin |
|---|---|---|---|---|---|---|---|---|---|
| Observed Zero Auto | 93,655 | 15,360 | 31,720 | 56,825 | 22,240 | 8,530 | 2,805 | 9,895 | 5,015 |
| Model Zero Auto | 90,934 | 17,364 | 35,235 | 61,395 | 18,494 | 6,553 | 2,248 | 8,237 | 4,273 |
| Observed One Auto | 138,440 | 80,840 | 163,555 | 182,105 | 104,315 | 37,700 | 14,650 | 54,390 | 35,080 |
| Model One Auto | 146,620 | 77,495 | 164,164 | 181,283 | 99,747 | 38,045 | 14,483 | 54,984 | 30,812 |
| Observed Two+ Autos | 97,750 | 158,030 | 371,210 | 284,855 | 217,875 | 84,210 | 27,955 | 108,395 | 60,650 |
| Model Two+ Autos | 92,098 | 159,198 | 366,415 | 279,822 | 225,615 | 85,788 | 28,656 | 109,155 | 65,562 |

**Figure 5.3**




| | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin |
|---|---|---|---|---|---|---|---|---|---|
| Observed Zero Workers | 81,875 | 54,320 | 100,775 | 119,650 | 78,045 | 28,790 | 12,090 | 42,045 | 22,180 |
| Model Zero Workers | 90,415 | 48,013 | 95,241 | 114,438 | 75,998 | 29,897 | 12,980 | 46,680 | 23,408 |
| Observed One Worker | 130,695 | 90,265 | 214,440 | 200,065 | 129,390 | 46,815 | 15,965 | 61,415 | 40,790 |
| Model One Worker | 116,184 | 95,710 | 206,160 | 197,097 | 132,727 | 52,127 | 18,151 | 69,017 | 39,163 |
| Observed Two+ Workers | 117,275 | 109,645 | 251,270 | 204,070 | 136,995 | 54,835 | 17,355 | 69,220 | 37,775 |
| Model Two+ Workers | 123,053 | 110,334 | 264,413 | 210,965 | 135,131 | 48,362 | 14,256 | 56,679 | 38,076 |

### 5.3 Trip Distribution

Trip distribution models are the second step of models in the four-step trip-based model process. Trip distribution is applied to link together the trip productions and attractions, by each trip purpose, from trip generation. The trip distribution model used in the Alameda Countywide model are typical gravity models, and are based on the methodologies used by MTC in the BAYCAST-90 model series. Gravity models use the analogy and mathematic equation of physical gravity to link the trip productions and attractions, as travel between a TAZ and all other TAZs is directly related to the relative attractiveness of the TAZ of interest to all other TAZs and inversely related to the impedance (travel time, distance or other measures) between each TAZ pair. As an example, a TAZ in the downtown Oakland business district with a large number of job attractions would draw from a very large area, but based on differences in transportation accessibility or geographical obstacles would draw trip productions from different directions in different proportions. For this project, the existing trip distribution models was recalibrated using observed census and travel survey data, as opposed to estimating new trip distribution models using a new model formulation different from the existing gravity models. At the regional level, the calibration of the trip distribution models to year 2000 observed conditions yielded a very close match to the average trip lengths estimated from the MTC BATS 2000 data. In addition, the County-to-County trip flows from the model compared to 2000 MTC BATS data, while not an exact match, show good agreement, particularly for Alameda County interchanges.

#### 5.3.1 Calibration Process

Based on discussions with the Model Task Force, it was agreed that trip distribution calibration would first be based on year 2000 inputs and data and then applied for the year 2010 using the new model TAZ structure, land use data and networks for the 2010 model validation. The starting point for calibration was to obtain year 2000 observed data. The primary sources of data used to calibrate the trip distribution models were from the 2000 Census Transportation Planning Package (CTPP) for home-based work trips and the MTC 2000 Regional Bay Area Transportation Survey (BATS) for both work and non-work trips. Specifically, the CTPP data was used to generate commuter trips by County-to-County flow and to stratify trips by income quartile, and the MTC 2000 BATS data was used to develop County-to-County trip flows for non-work trips. Travel time and distance inputs were generated from the 2000 Alameda Countywide model roadway networks for peak and off-peak period times. AM peak period congested travel times were used as the impedance measure for home-based school and home-based work trip purpose, while a blended AM peak and free flow travel time was used for the non-work trip purposes.

Trip productions and attractions were developed by applying the Alameda Countywide model trip generation models for the base year 2000. For all trip purposes, if the trip productions and attractions by County did not compare well with the MTC BATS County productions and attractions or CTPP data, the trip generation results were adjusted to more closely match the observed totals before the comparison to observed totals.

The final data element required by the trip distribution models were the model friction factors. Friction factors are applied using lookup tables that substitute calibrated friction factors for each mile of travel distance. The existing Alameda County model friction factors were used as a starting point in the application of the gravity models, as these were based on the original MTC BAYCAST-90 friction factor curves with slight adjustments applied during the previous calibration.

### 5.3.2 Trip Distribution Calibration Results

Calibration of the trip distribution models was an iterative process based on a comparison of two primary outputs: average trip lengths and County-to-County trip flows. Based on recommendations from MTC, average trip distance was used as the impedance measure in the trip distribution gravity models, consistent with what is used in the current MTC activity-based models. One of the simplifying aspects of the model calibration was the use of the existing friction factor curves. The initial application of the gravity models yielded acceptable average trip lengths, reported in miles, for each trip purpose

**Average Trip Lengths.** Average trip lengths by trip purpose are summarized in Table 5.4, showing a comparison to MTC BATS 2000 average trip lengths and the Alameda CTC model calibrated results. These are the final average trip lengths generated after the application of county-level k-factors to calibrate County-to-County trip flows (described in the next section). The calibrated Alameda CTC model average trip lengths are very close to the MTC BATS 2000 trip lengths, when reported in miles, and not exceedingly different when reported in minutes.

**County to County Trip Flows.** The comparison of the County to County trip flows is an important means for assessing the reasonableness of the trip distribution models at a level more detailed than a comparison of average trip lengths that are reported at the regional level. Calibration of the county trip flows is accomplished by the application of model k-factors. K-factors adjust the attractiveness of trip interchanges by scaling the relative attractiveness. Typically, they are applied to account for effects such as geographical barriers to travel (such as bodies of water) or corrections to socio-economic factors not directly expressed in the gravity model formulas. K-factor values of greater than 1.0 increase trip interchanges, while values less than 1.0 decrease attractiveness. It is important to ensure that k-factors are not overly large or small, as they can have serious multiplicative effects when forecasts are applied, especially in rapidly changing or redeveloping areas.

By comparing the estimated trip by county to the observed trips by county, model k-factors were calibrated for each county-level interchange. This is a significant departure from the previous trip distribution models and the original application in BAYCAST-90, which applied superdistrict level k-factors. Tables 5.5 through 5.11 summarize the trips by county for all trip purposes. As a general calibration goal, the model was deemed calibrated if county-level trips were within 5 to 10 percent of modeled versus observed, particularly for Alameda County trip interchanges and for large county flows (over 25,000 trips), and less so for other County trip interchanges or small county flows (<25,000 trips).

## Table 5.4 Average Trip Lengths by Trip Purpose

| Trip Purpose | MTC BATS 2000 | | | Alameda CTC-2000 | | | Percent Difference MTC v. ACTC | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Home-based Work | Total Person Trips | Average Trip Distance, miles | Average Trip Time, minutes | Total Person Trips | Average Trip Distance, miles | Average Trip Time, minutes | Total Person Trips | Average Trip Distance, miles | Average Trip Time, minutes | Coincidence Ratio |
| Income Quartile 1 (Low) | 568,186 | 8.02 | 16.31 | 569,637 | 8.69 | 17.88 | 0.26% | 8.35% | 9.63% | 0.85 |
| Income Quartile 2 (Low-Medium) | 1,009,552 | 11.43 | 21.94 | 1,010,193 | 10.9 | 21.7 | 0.06% | -4.64% | -1.09% | 0.86 |
| Income Quartile 3 (Medium-High) | 1,477,524 | 12.73 | 24.69 | 1,593,845 | 12.08 | 23.73 | 7.87% | -5.11% | -3.89% | 0.84 |
| Income Quartile 4 (High) | 1,991,777 | 13.67 | 26.07 | 1,980,138 | 13.83 | 26.32 | -0.58% | 1.17% | 0.96% | 0.89 |
| Total Home-based Work | 5,047,039 | 12.31 | 23.74 | 5,153,813 | 12.15 | 23.68 | 2.12% | -1.30% | -0.25% | 0.91 |
| Home-based Shopping/Other | 5,348,023 | 4.4 | 9.46 | 5,316,725 | 4.91 | 10.4 | -0.59% | 11.59% | 9.94% | 0.84 |
| Home-based Social-Recreational | 3,624,432 | 6.53 | 13.28 | 3,601,625 | 6.37 | 13.14 | -0.63% | -2.45% | -1.05% | 0.9 |
| Non-home-based | 4,646,549 | 6.1 | 11.88 | 4,651,401 | 5.72 | 11.54 | 0.10% | -6.23% | -2.86% | 0.87 |
| Home-based Grade School | 1,467,787 | 4.87 | 10.52 | 1,477,834 | 2.89 | 5.59 | 0.68% | -40.66% | -46.86% | 0.75 |
| Home-based High School | 460,266 | 4.65 | 10.27 | 462,851 | 4.74 | 10.23 | 0.56% | -1.94% | -0.39% | 0.85 |
| Home-based College | 522,212 | 7.52 | 14.84 | 522,033 | 8.02 | 16.27 | -0.03% | -6.65% | -9.64% | 0.80 |
| All Trips | 21,116,308 | 9.98 | 20.12 | 21,253,973 | 9.99 | 20.42 | 0.65% | 0.10% | 1.49% | NA |

## Table 5.5 County to County Trips – Home-based Work, All Income Quartiles

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | San Joaquin | All |
|---|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 518,597 | 65,376 | 22,412 | 27,114 | 6,216 | 510 | 291 | 1,259 | 9,261 | 57 | 651,093 |
| San Mateo | 124,881 | 337,556 | 92,352 | 20,991 | 2,721 | 390 | 189 | 640 | 1,753 | 115 | 581,587 |
| Santa Clara | 14,414 | 59,540 | 1,174,573 | 50,425 | 4,705 | 808 | 332 | 690 | 994 | 461 | 1,306,942 |
| Alameda | 128,721 | 53,552 | 110,153 | 695,479 | 56,573 | 2,628 | 639 | 1,764 | 7,137 | 2,126 | 1,058,772 |
| Contra Costa | 89,728 | 15,064 | 31,432 | 133,521 | 388,991 | 12,016 | 2,893 | 2,862 | 11,897 | 4,591 | 692,994 |
| Solano | 24,970 | 4,824 | 5,358 | 17,941 | 33,560 | 148,823 | 13,557 | 4,697 | 6,845 | 477 | 261,051 |
| Napa | 3,049 | 669 | 971 | 1,672 | 2,884 | 5,452 | 67,541 | 3,677 | 1,344 | 68 | 87,327 |
| Sonoma | 18,620 | 2,362 | 3,313 | 3,599 | 3,110 | 1,801 | 4,659 | 277,149 | 27,121 | 94 | 341,828 |
| Marin | 53,470 | 3,605 | 4,134 | 5,984 | 5,854 | 782 | 535 | 5,401 | 113,007 | 131 | 192,903 |
| San Joaquin | 4,201 | 2,698 | 12,980 | 29,044 | 7,377 | 1,154 | 320 | 711 | 455 | 250,227 | 309,166 |
| All | 980,652 | 545,247 | 1,457,677 | 985,770 | 511,990 | 174,364 | 90,956 | 298,848 | 179,814 | 258,346 | 5,483,664 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | San Joaquin | All |
|---|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 522,347 | 63,538 | 24,420 | 27,917 | 6,316 | 550 | 345 | 1,205 | 9,016 | 27 | 655,681 |
| San Mateo | 129,972 | 333,805 | 94,716 | 21,988 | 2,752 | 427 | 218 | 550 | 1,511 | 75 | 586,014 |
| Santa Clara | 13,736 | 63,024 | 1,181,433 | 52,534 | 4,117 | 825 | 249 | 724 | 860 | 328 | 1,317,830 |
| Alameda | 132,001 | 55,135 | 120,602 | 678,471 | 55,174 | 2,848 | 561 | 1,364 | 5,869 | 2,226 | 1,054,251 |
| Contra Costa | 90,600 | 15,227 | 17,494 | 144,030 | 393,433 | 9,853 | 1,792 | 1,657 | 10,639 | 2,573 | 687,298 |
| Solano | 19,517 | 4,856 | 2,819 | 19,379 | 35,025 | 150,981 | 13,896 | 3,825 | 7,033 | 543 | 257,874 |
| Napa | 2,282 | 729 | 610 | 1,757 | 2,918 | 5,427 | 68,343 | 3,287 | 1,336 | 0 | 86,689 |
| Sonoma | 14,344 | 2,511 | 2,044 | 3,407 | 2,633 | 1,887 | 4,785 | 280,759 | 27,473 | 0 | 339,843 |
| Marin | 53,697 | 4,102 | 1,572 | 6,778 | 4,054 | 881 | 604 | 5,271 | 115,940 | 90 | 192,989 |
| San Joaquin | 2,155 | 2,320 | 11,967 | 29,508 | 5,568 | 686 | 162 | 206 | 139 | 252,484 | 305,195 |
| All | 980,651 | 545,247 | 1,457,677 | 985,769 | 511,990 | 174,365 | 90,955 | 298,848 | 179,816 | 258,346 | 5,483,664 |

| **Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | San Joaquin | All |
|---|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 0.99 | 1.03 | 0.92 | 0.97 | 0.98 | 0.93 | 0.84 | 1.04 | 1.03 | 2.13 | 0.99 |
| San Mateo | 0.96 | 1.01 | 0.98 | 0.95 | 0.99 | 0.91 | 0.87 | 1.16 | 1.16 | 1.53 | 0.99 |
| Santa Clara | 1.05 | 0.94 | 0.99 | 0.96 | 1.14 | 0.98 | 1.33 | 0.95 | 1.16 | 1.41 | 0.99 |
| Alameda | 0.98 | 0.97 | 0.91 | 1.03 | 1.03 | 0.92 | 1.14 | 1.29 | 1.22 | 0.95 | 1.00 |
| Contra Costa | 0.99 | 0.99 | 1.80 | 0.93 | 0.99 | 1.22 | 1.61 | 1.73 | 1.12 | 1.78 | 1.01 |
| Solano | 1.28 | 0.99 | 1.90 | 0.93 | 0.96 | 0.99 | 0.98 | 1.23 | 0.97 | 0.88 | 1.01 |
| Napa | 1.34 | 0.92 | 1.59 | 0.95 | 0.99 | 1.00 | 0.99 | 1.12 | 1.01 | | 1.01 |
| Sonoma | 1.30 | 0.94 | 1.62 | 1.06 | 1.18 | 0.95 | 0.97 | 0.99 | 0.99 | | 1.01 |
| Marin | 1.00 | 0.88 | 2.63 | 0.88 | 1.44 | 0.89 | 0.89 | 1.02 | 0.97 | 1.45 | 1.00 |
| San Joaquin | 1.95 | 1.16 | 1.08 | 0.98 | 1.32 | 1.68 | 1.97 | 3.45 | 3.27 | 0.99 | 1.01 |
| All | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

**Table 5.6 County to County Trips – Home-based Shop/Other**

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 490,344 | 47,051 | 1,366 | 5,263 | 1,206 | 296 | 123 | 509 | 3,346 | 549,504 |
| San Mateo | 37,032 | 470,105 | 32,938 | 3,012 | 887 | 408 | 184 | 8 | 417 | 544,991 |
| Santa Clara | 1,992 | 14,176 | 1,304,774 | 6,444 | 1,411 | 513 | 67 | 150 | 313 | 1,329,840 |
| Alameda | 17,843 | 5,972 | 20,573 | 1,042,342 | 30,637 | 170 | 78 | 178 | 1,243 | 1,119,036 |
| Contra Costa | 12,404 | 1,112 | 1,846 | 50,760 | 746,134 | 5,285 | 348 | 469 | 2,292 | 820,650 |
| Solano | 1,466 | 191 | 162 | 3,345 | 7,687 | 279,199 | 2,967 | 353 | 498 | 295,868 |
| Napa | 190 | 92 | 70 | 233 | 464 | 3,028 | 87,004 | 1,306 | 444 | 92,832 |
| Sonoma | 2,838 | 382 | 831 | 761 | 466 | 414 | 1,921 | 367,810 | 6,364 | 381,787 |
| Marin | 6,294 | 459 | 275 | 1,243 | 970 | 378 | 59 | 4,371 | 200,017 | 214,065 |
| All | 570,403 | 539,541 | 1,362,835 | 1,113,404 | 789,861 | 289,692 | 92,751 | 375,154 | 214,933 | 5,348,574 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 484,820 | 43,471 | 2,752 | 5,385 | 1,161 | 693 | 439 | 487 | 2,917 | 542,125 |
| San Mateo | 40,178 | 476,046 | 32,021 | 3,168 | 934 | 898 | 404 | 0 | 400 | 554,050 |
| Santa Clara | 2,099 | 15,281 | 1,309,955 | 6,853 | 1,478 | 531 | 0 | 143 | 299 | 1,336,640 |
| Alameda | 18,914 | 5,923 | 18,460 | 1,040,475 | 33,392 | 184 | 64 | 167 | 1,160 | 1,118,741 |
| Contra Costa | 12,571 | 1,038 | 1,657 | 50,709 | 742,194 | 6,102 | 38 | 423 | 2,080 | 816,811 |
| Solano | 1,491 | 178 | 142 | 3,181 | 9,788 | 276,877 | 2,942 | 314 | 438 | 295,351 |
| Napa | 233 | 102 | 65 | 498 | 546 | 3,754 | 85,861 | 1,380 | 485 | 92,924 |
| Sonoma | 3,201 | 387 | 897 | 1,214 | 500 | 452 | 1,819 | 367,737 | 6,424 | 382,632 |
| Marin | 6,908 | 468 | 262 | 1,300 | 291 | 415 | 63 | 4,261 | 194,782 | 208,751 |
| All | 570,416 | 542,895 | 1,366,212 | 1,112,784 | 790,283 | 289,907 | 91,630 | 374,913 | 208,985 | 5,348,023 |

| **Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 1.01 | 1.08 | 0.50 | 0.98 | 1.04 | 0.43 | 0.28 | 1.05 | 1.15 | 1.01 |
| San Mateo | 0.92 | 0.99 | 1.03 | 0.95 | 0.95 | 0.45 | 0.46 | | 1.04 | 0.98 |
| Santa Clara | 0.95 | 0.93 | 1.00 | 0.94 | 0.95 | 0.97 | | 1.05 | 1.05 | 0.99 |
| Alameda | 0.94 | 1.01 | 1.11 | 1.00 | 0.92 | 0.92 | 1.22 | 1.07 | 1.07 | 1.00 |
| Contra Costa | 0.99 | 1.07 | 1.11 | 1.00 | 1.01 | 0.87 | 9.18 | 1.11 | 1.10 | 1.00 |
| Solano | 0.98 | 1.08 | 1.14 | 1.05 | 0.79 | 1.01 | 1.01 | 1.12 | 1.14 | 1.00 |
| Napa | 0.81 | 0.90 | 1.07 | 0.47 | 0.85 | 0.81 | 1.01 | 0.95 | 0.92 | 1.00 |
| Sonoma | 0.89 | 0.99 | 0.93 | 0.63 | 0.93 | 0.92 | 1.06 | 1.00 | 0.99 | 1.00 |
| Marin | 0.91 | 0.98 | 1.05 | 0.96 | 3.34 | 0.91 | 0.93 | 1.03 | 1.03 | 1.03 |
| All | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.00 | 1.03 | 1.00 |

## Table 5.7 County to County Trips – Home-based Social-Recreational

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 350,224 | 25,774 | 9,143 | 12,719 | 2,107 | 463 | 309 | 500 | 3,330 | 404,571 |
| San Mateo | 46,182 | 298,670 | 22,571 | 4,460 | 1,760 | 317 | 47 | 142 | 1,095 | 375,244 |
| Santa Clara | 5,554 | 18,680 | 837,168 | 19,078 | 3,926 | 774 | 10 | 56 | 445 | 885,691 |
| Alameda | 37,879 | 9,146 | 20,696 | 677,213 | 26,693 | 1,538 | 179 | 686 | 1,248 | 775,279 |
| Contra Costa | 20,209 | 4,122 | 4,390 | 60,069 | 425,742 | 6,598 | 1,196 | 696 | 2,818 | 525,839 |
| Solano | 2,983 | 775 | 465 | 7,310 | 7,593 | 148,408 | 3,270 | 1,609 | 1,854 | 174,266 |
| Napa | 457 | 479 | 41 | 130 | 439 | 3,052 | 53,940 | 2,589 | 365 | 61,493 |
| Sonoma | 2,568 | 163 | 5 | 275 | 386 | 577 | 1,487 | 241,630 | 9,129 | 256,222 |
| Marin | 13,471 | 555 | 540 | 2,562 | 1,352 | 279 | 475 | 3,513 | 143,094 | 165,841 |
| All | 479,527 | 358,366 | 895,019 | 783,817 | 469,999 | 162,005 | 60,913 | 251,421 | 163,380 | 3,624,446 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 347,245 | 26,134 | 8,987 | 13,172 | 761 | 541 | 341 | 50 | 3,633 | 400,866 |
| San Mateo | 45,241 | 298,057 | 22,404 | 4,562 | 812 | 359 | 0 | 54 | 468 | 371,957 |
| Santa Clara | 5,499 | 14,916 | 840,976 | 19,710 | 2,101 | 864 | 0 | 392 | 65 | 884,523 |
| Alameda | 40,643 | 8,520 | 18,476 | 690,556 | 26,524 | 1,627 | 180 | 664 | 921 | 788,111 |
| Contra Costa | 18,388 | 3,834 | 3,922 | 57,837 | 431,743 | 3,742 | 0 | 660 | 2,431 | 522,556 |
| Solano | 2,652 | 697 | 405 | 6,771 | 4,613 | 152,770 | 3,196 | 1,490 | 1,640 | 174,235 |
| Napa | 425 | 456 | 144 | 125 | 187 | 3,289 | 55,792 | 2,501 | 342 | 63,263 |
| Sonoma | 3,558 | 159 | 1,827 | 273 | 405 | 640 | 1,609 | 238,755 | 8,631 | 255,856 |
| Marin | 13,359 | 562 | 526 | 2,659 | 295 | 126 | 529 | 3,647 | 141,364 | 163,067 |
| All | 477,012 | 353,335 | 897,667 | 795,666 | 467,440 | 163,957 | 61,647 | 248,213 | 159,494 | 3,624,432 |

| **Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 1.01 | 0.99 | 1.02 | 0.97 | 2.77 | 0.86 | 0.91 | 9.93 | 0.92 | 1.01 |
| San Mateo | 1.02 | 1.00 | 1.01 | 0.98 | 2.17 | 0.88 | | 2.65 | 2.34 | 1.01 |
| Santa Clara | 1.01 | 1.25 | 1.00 | 0.97 | 1.87 | 0.90 | | 0.14 | 6.86 | 1.00 |
| Alameda | 0.93 | 1.07 | 1.12 | 0.98 | 1.01 | 0.95 | 0.99 | 1.03 | 1.36 | 0.98 |
| Contra Costa | 1.10 | 1.08 | 1.12 | 1.04 | 0.99 | 1.76 | | 1.05 | 1.16 | 1.01 |
| Solano | 1.12 | 1.11 | 1.15 | 1.08 | 1.65 | 0.97 | 1.02 | 1.08 | 1.13 | 1.00 |
| Napa | 1.07 | 1.05 | 0.29 | 1.03 | 2.35 | 0.93 | 0.97 | 1.04 | 1.07 | 0.97 |
| Sonoma | 0.72 | 1.03 | 0.00 | 1.01 | 0.95 | 0.90 | 0.92 | 1.01 | 1.06 | 1.00 |
| Marin | 1.01 | 0.99 | 1.03 | 0.96 | 4.58 | 2.21 | 0.90 | 0.96 | 1.01 | 1.02 |
| All | 1.01 | 1.01 | 1.00 | 0.99 | 1.01 | 0.99 | 0.99 | 1.01 | 1.02 | 1.00 |

### Table 5.8 County to County Trips – Non-home-based

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 604,327 | 43,517 | 9,970 | 29,180 | 17,336 | 2,474 | 419 | 2,666 | 13,589 | 723,477 |
| San Mateo | 26,642 | 371,709 | 41,757 | 11,212 | 2,290 | 791 | 169 | 360 | 840 | 455,771 |
| Santa Clara | 12,800 | 39,579 | 1,120,079 | 28,731 | 4,818 | 930 | 150 | 938 | 324 | 1,208,350 |
| Alameda | 25,036 | 13,735 | 29,969 | 815,610 | 56,962 | 3,063 | 285 | 1,373 | 3,514 | 949,545 |
| Contra Costa | 7,692 | 1,271 | 3,204 | 41,552 | 489,050 | 7,822 | 558 | 1,458 | 4,003 | 556,611 |
| Solano | 1,835 | 514 | 956 | 4,853 | 9,032 | 152,613 | 5,093 | 848 | 592 | 176,335 |
| Napa | 385 | 80 | 176 | 368 | 417 | 3,343 | 73,564 | 2,298 | 520 | 81,152 |
| Sonoma | 1,503 | 495 | 766 | 411 | 1,047 | 793 | 1,951 | 290,901 | 6,083 | 303,951 |
| Marin | 8,332 | 1,147 | 461 | 5,180 | 3,077 | 849 | 746 | 6,497 | 167,040 | 193,330 |
| All | 688,553 | 472,047 | 1,207,339 | 937,097 | 584,030 | 172,677 | 82,933 | 307,340 | 196,505 | 4,648,522 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 615,483 | 43,736 | 10,211 | 29,786 | 17,960 | 2,423 | 419 | 2,832 | 13,629 | 736,479 |
| San Mateo | 26,573 | 367,293 | 43,102 | 11,280 | 2,306 | 760 | 167 | 373 | 836 | 452,691 |
| Santa Clara | 12,872 | 39,554 | 1,128,121 | 28,641 | 4,756 | 882 | 82 | 971 | 253 | 1,216,132 |
| Alameda | 24,668 | 13,430 | 29,831 | 806,101 | 56,044 | 2,902 | 282 | 1,410 | 3,416 | 938,083 |
| Contra Costa | 8,988 | 1,554 | 3,263 | 42,164 | 488,417 | 6,987 | 501 | 1,514 | 3,942 | 557,329 |
| Solano | 1,821 | 505 | 978 | 4,862 | 9,033 | 148,783 | 5,036 | 880 | 773 | 172,670 |
| Napa | 390 | 78 | 235 | 378 | 256 | 3,311 | 74,793 | 2,488 | 528 | 82,457 |
| Sonoma | 1,435 | 464 | 776 | 516 | 998 | 749 | 1,839 | 290,656 | 5,681 | 303,112 |
| Marin | 8,284 | 1,089 | 451 | 5,116 | 3,030 | 760 | 714 | 6,644 | 161,509 | 187,596 |
| All | 700,513 | 467,702 | 1,216,967 | 928,844 | 582,799 | 167,557 | 83,832 | 307,766 | 190,568 | 4,646,549 |

| **Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 0.98 | 0.99 | 0.98 | 0.98 | 0.97 | 1.02 | 1.00 | 0.94 | 1.00 | 0.98 |
| San Mateo | 1.00 | 1.01 | 0.97 | 0.99 | 0.99 | 1.04 | 1.01 | 0.97 | 1.00 | 1.01 |
| Santa Clara | 0.99 | 1.00 | 0.99 | 1.00 | 1.01 | 1.05 | 1.83 | 0.97 | 1.28 | 0.99 |
| Alameda | 1.01 | 1.02 | 1.00 | 1.01 | 1.02 | 1.06 | 1.01 | 0.97 | 1.03 | 1.01 |
| Contra Costa | 0.86 | 0.82 | 0.98 | 0.99 | 1.00 | 1.12 | 1.11 | 0.96 | 1.02 | 1.00 |
| Solano | 1.01 | 1.02 | 0.98 | 1.00 | 1.00 | 1.03 | 1.01 | 0.96 | 0.77 | 1.02 |
| Napa | 0.99 | 1.03 | 0.75 | 0.97 | 1.63 | 1.01 | 0.98 | 0.92 | 0.98 | 0.98 |
| Sonoma | 1.05 | 1.07 | 0.99 | 0.80 | 1.05 | 1.06 | 1.06 | 1.00 | 1.07 | 1.00 |
| Marin | 1.01 | 1.05 | 1.02 | 1.01 | 1.02 | 1.12 | 1.05 | 0.98 | 1.03 | 1.03 |
| All | 0.98 | 1.01 | 0.99 | 1.01 | 1.00 | 1.03 | 0.99 | 1.00 | 1.03 | 1.00 |

## Table 5.9 County to County Trips – Home-based Grade School

| Modeled Trips | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 110,981 | 6,972 | 0 | 125 | 4 | 0 | 0 | 0 | 50 | 118,132 |
| San Mateo | 7,213 | 164,431 | 1,576 | 66 | 0 | 0 | 0 | 0 | 0 | 173,286 |
| Santa Clara | 0 | 1,659 | 367,620 | 1,036 | 2 | 0 | 0 | 0 | 0 | 370,318 |
| Alameda | 59 | 245 | 797 | 355,087 | 3,011 | 0 | 0 | 0 | 0 | 359,200 |
| Contra Costa | 5 | 34 | 3 | 3,567 | 205,997 | 373 | 21 | 3 | 80 | 210,083 |
| Solano | 0 | 3 | 0 | 4 | 655 | 85,425 | 535 | 16 | 26 | 86,664 |
| Napa | 0 | 2 | 0 | 3 | 65 | 632 | 34,130 | 116 | 26 | 34,974 |
| Sonoma | 2 | 8 | 0 | 1 | 32 | 36 | 185 | 86,087 | 216 | 86,565 |
| Marin | 232 | 40 | 0 | 5 | 105 | 14 | 11 | 51 | 38,079 | 38,538 |
| All | 118,492 | 173,393 | 369,996 | 359,894 | 209,870 | 86,480 | 34,882 | 86,273 | 38,478 | 1,477,759 |

| Observed Trips | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 113,610 | 3,979 | 0 | 0 | 0 | 0 | 0 | 0 | 643 | 118,232 |
| San Mateo | 12,547 | 158,238 | 2,033 | 80 | 0 | 0 | 0 | 202 | 39 | 173,139 |
| Santa Clara | 283 | 1,189 | 367,729 | 1,011 | 260 | 0 | 0 | 0 | 0 | 370,472 |
| Alameda | 304 | 1,629 | 3,127 | 347,481 | 6,380 | 395 | 0 | 0 | 0 | 359,316 |
| Contra Costa | 0 | 727 | 0 | 7,306 | 188,216 | 7,713 | 0 | 0 | 0 | 203,962 |
| Solano | 328 | 0 | 0 | 118 | 3,230 | 81,544 | 717 | 0 | 0 | 85,937 |
| Napa | 180 | 0 | 0 | 315 | 485 | 218 | 33,716 | 0 | 0 | 34,914 |
| Sonoma | 0 | 0 | 0 | 0 | 0 | 0 | 139 | 82,327 | 1,375 | 83,841 |
| Marin | 372 | 325 | 1,513 | 0 | 118 | 0 | 0 | 152 | 35,494 | 37,974 |
| All | 127,624 | 166,087 | 374,402 | 356,311 | 198,689 | 89,870 | 34,572 | 82,681 | 37,551 | 1,467,787 |

| **Share Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 0.98 | 1.75 | | | | | | | 0.08 | 1.00 |
| San Mateo | 0.57 | 1.04 | 0.78 | 0.82 | | | | | 0.01 | 1.00 |
| Santa Clara | | 1.40 | 1.00 | 1.03 | 0.01 | | | | | 1.00 |
| Alameda | 0.19 | 0.15 | 0.25 | 1.02 | 0.47 | | | | | 1.00 |
| Contra Costa | | 0.05 | | 0.49 | 1.09 | 0.05 | 0.00 | | | 1.03 |
| Solano | | | | 0.04 | 0.20 | 1.05 | 0.75 | | | 1.01 |
| Napa | | | | 0.01 | 0.13 | 2.90 | 1.01 | | | 1.00 |
| Sonoma | | | | | | | 1.33 | 1.05 | 0.16 | 1.03 |
| Marin | 0.62 | 0.12 | | | 0.89 | | | 0.34 | 1.07 | 1.01 |
| All | 0.93 | 1.04 | 0.99 | 1.01 | 1.06 | 0.96 | 1.01 | 1.04 | 1.02 | 1.01 |

### Table 5.10 County to County Trips – Home-based High School

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 30,295 | 2,162 | 7 | 50 | 25 | 0 | 0 | 0 | 0 | 32,540 |
| San Mateo | 2,408 | 42,910 | 885 | 103 | 4 | 0 | 0 | 0 | 0 | 46,311 |
| Santa Clara | 0 | 431 | 116,005 | 410 | 6 | 0 | 0 | 0 | 0 | 116,852 |
| Alameda | 285 | 1,044 | 1,457 | 98,185 | 3,900 | 16 | 1 | 0 | 0 | 104,887 |
| Contra Costa | 33 | 41 | 9 | 1,450 | 64,487 | 1,467 | 46 | 20 | 7 | 67,562 |
| Solano | 0 | 0 | 0 | 2 | 434 | 29,828 | 294 | 61 | 0 | 30,620 |
| Napa | 0 | 0 | 0 | 0 | 26 | 369 | 8,892 | 230 | 0 | 9,518 |
| Sonoma | 0 | 0 | 0 | 0 | 3 | 12 | 205 | 32,350 | 2 | 32,571 |
| Marin | 1,300 | 556 | 2 | 153 | 752 | 290 | 227 | 3,668 | 15,028 | 21,977 |
| All | 34,321 | 47,144 | 118,366 | 100,353 | 69,637 | 31,983 | 9,665 | 36,329 | 15,038 | 462,836 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 32,499 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32,499 |
| San Mateo | 2,559 | 42,368 | 759 | 394 | 0 | 0 | 0 | 0 | 0 | 46,080 |
| Santa Clara | 174 | 443 | 115,358 | 529 | 0 | 349 | 0 | 0 | 0 | 116,853 |
| Alameda | 660 | 768 | 1,020 | 102,186 | 0 | 0 | 0 | 0 | 0 | 104,634 |
| Contra Costa | 0 | 0 | 0 | 4,466 | 61,112 | 0 | 0 | 50 | 66 | 65,694 |
| Solano | 219 | 0 | 0 | 0 | 730 | 29,037 | 499 | 0 | 0 | 30,485 |
| Napa | 0 | 0 | 0 | 0 | 0 | 139 | 9,368 | 0 | 0 | 9,507 |
| Sonoma | 0 | 0 | 0 | 0 | 0 | 0 | 484 | 31,386 | 640 | 32,510 |
| Marin | 453 | 0 | 0 | 128 | 0 | 0 | 0 | 90 | 21,333 | 22,004 |
| All | 36,564 | 43,579 | 117,137 | 107,703 | 61,842 | 29,525 | 10,351 | 31,526 | 22,039 | 460,266 |

| **Share Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 0.93 | | | | | | | | | 1.00 |
| San Mateo | 0.94 | 1.01 | 1.17 | 0.26 | | | | | | 1.01 |
| Santa Clara | | 0.97 | 1.01 | 0.78 | | | | | | 1.00 |
| Alameda | 0.43 | 1.36 | 1.43 | 0.96 | | | | | | 1.00 |
| Contra Costa | | | | 0.32 | 1.06 | | | 0.40 | 0.11 | 1.03 |
| Solano | | | | | 0.59 | 1.03 | 0.59 | | | 1.00 |
| Napa | | | | | | 2.66 | 0.95 | | | 1.00 |
| Sonoma | | | | | | | 0.42 | 1.03 | | 1.00 |
| Marin | 2.87 | | | 1.19 | | | | 40.76 | 0.70 | 1.00 |
| All | 0.94 | 1.08 | 1.01 | 0.93 | 1.13 | 1.08 | 0.93 | 1.15 | 0.68 | 1.01 |

## Table 5.11 County to County Trips – Home-based College

| **Modeled Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 57,451 | 139 | 354 | 3,952 | 127 | 43 | 0 | 4 | 136 | 62,207 |
| San Mateo | 7,619 | 40,343 | 3,536 | 1,315 | 100 | 3 | 1 | 7 | 54 | 52,978 |
| Santa Clara | 1,265 | 1,703 | 114,248 | 2,833 | 498 | 31 | 18 | 35 | 31 | 120,662 |
| Alameda | 3,937 | 1,191 | 3,803 | 121,663 | 4,120 | 147 | 7 | 21 | 55 | 134,943 |
| Contra Costa | 1,459 | 115 | 1,240 | 10,184 | 54,481 | 647 | 83 | 89 | 403 | 68,699 |
| Solano | 317 | 26 | 17 | 925 | 3,337 | 13,598 | 222 | 335 | 86 | 18,862 |
| Napa | 204 | 7 | 4 | 117 | 278 | 817 | 4,765 | 564 | 32 | 6,789 |
| Sonoma | 309 | 30 | 21 | 162 | 171 | 217 | 629 | 40,110 | 503 | 42,152 |
| Marin | 566 | 79 | 20 | 1,064 | 329 | 764 | 37 | 979 | 10,866 | 14,705 |
| All | 73,127 | 43,631 | 123,242 | 142,216 | 63,442 | 16,268 | 5,762 | 42,144 | 12,166 | 521,998 |

| **Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 57,567 | 96 | 525 | 3,872 | 0 | 50 | 0 | 0 | 130 | 62,240 |
| San Mateo | 6,392 | 42,491 | 2,900 | 1,163 | 0 | 0 | 0 | 0 | 0 | 52,946 |
| Santa Clara | 1,985 | 425 | 115,327 | 3,355 | 51 | 0 | 0 | 0 | 0 | 121,143 |
| Alameda | 4,023 | 458 | 3,024 | 122,684 | 4,137 | 172 | 0 | 0 | 0 | 134,498 |
| Contra Costa | 1,741 | 67 | 1,563 | 9,601 | 56,593 | 0 | 88 | 85 | 218 | 69,956 |
| Solano | 299 | 0 | 0 | 118 | 3,174 | 14,777 | 166 | 293 | 0 | 18,827 |
| Napa | 211 | 0 | 0 | 0 | 0 | 400 | 5,446 | 565 | 0 | 6,622 |
| Sonoma | 336 | 0 | 0 | 0 | 0 | 0 | 0 | 40,729 | 511 | 41,576 |
| Marin | 571 | 0 | 0 | 496 | 0 | 1,054 | 0 | 896 | 11,387 | 14,404 |
| All | 73,125 | 43,537 | 123,339 | 141,289 | 63,955 | 16,453 | 5,700 | 42,568 | 12,246 | 522,212 |

| **Share Modeled/Observed Trips** | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 1.00 | 1.45 | 0.67 | 1.02 | | 0.86 | | | 1.05 | 1.00 |
| San Mateo | 1.19 | 0.95 | 1.22 | 1.13 | | | | | | 1.00 |
| Santa Clara | 0.64 | 4.01 | 0.99 | 0.84 | 9.77 | | | | | 1.00 |
| Alameda | 0.98 | 2.60 | 1.26 | 0.99 | 1.00 | 0.85 | | | | 1.00 |
| Contra Costa | 0.84 | 1.71 | 0.79 | 1.06 | 0.96 | | 0.94 | 1.04 | 1.85 | 0.98 |
| Solano | 1.06 | | | 7.84 | 1.05 | 0.92 | 1.34 | 1.14 | | 1.00 |
| Napa | 0.97 | | | | | 2.04 | 0.88 | 1.00 | | 1.03 |
| Sonoma | 0.92 | | | | | | | 0.98 | 0.98 | 1.01 |
| Marin | 0.99 | | | 2.14 | | 0.73 | | 1.09 | 0.95 | 1.02 |
| All | 1.00 | 1.00 | 1.00 | 1.01 | 0.99 | 0.99 | 1.01 | 0.99 | 0.99 | 1.00 |

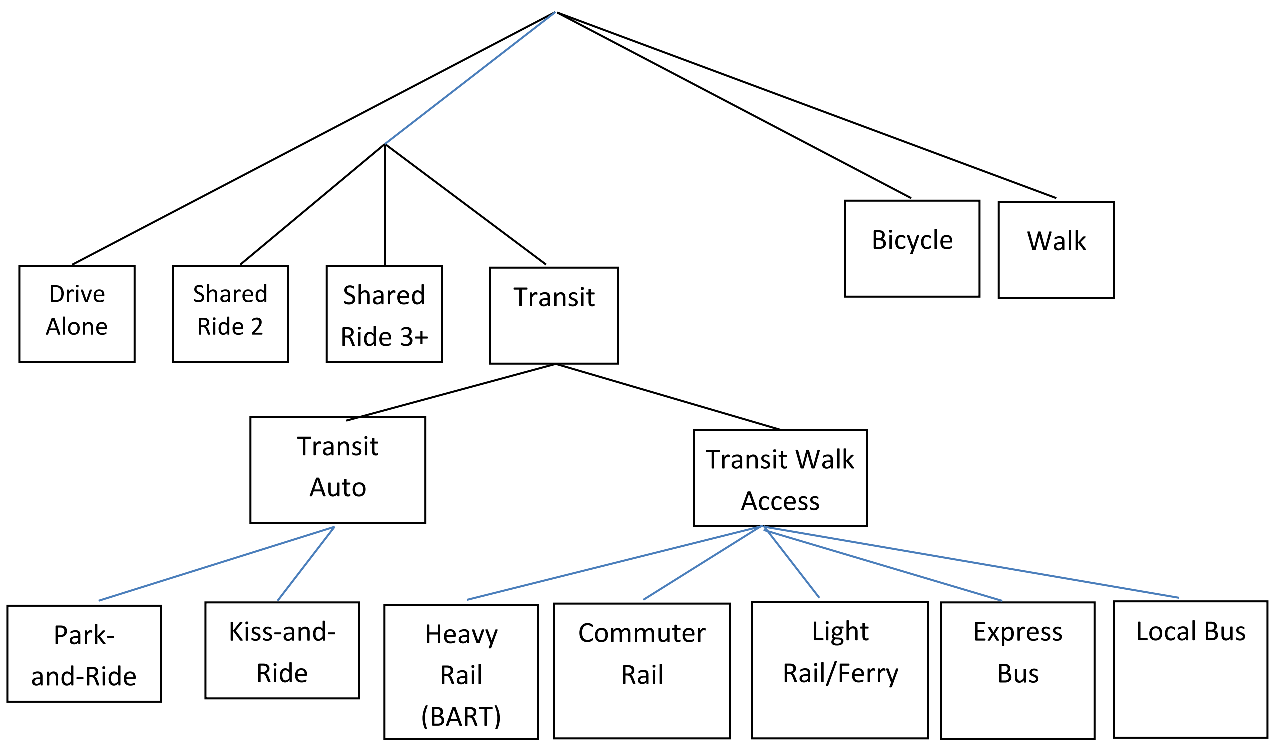
### 5.4 Mode Choice Model Structure and Model Coefficients

The standard form for mode choice models is the logit choice model. Six of the seven mode choice models included in the model set are nested logit choice model and one, the home-based grade school mode choice model, is multinomial logit. An important characteristic of most of the mode choice models (with the exception of the three home-based school mode choice models) is that both AM peak period and off-peak period travel times and trip costs are used in the model application. In previous versions of MTC model systems, home-based work trips were only sensitive to peak period travel times and costs; and non-work trips were only sensitive to off-peak times and costs. This improvement in the model system means that mode choice for these trip purposes is sensitive to changes in both the peak and off-peak period, as opposed to just one or the other.

All mode choice models incorporate non-motorized alternatives: bicycle and walk-only. Travel times for bicycle and walk are based on a "non-motorized network" based on the standard regional highway network, excluding freeway facilities where bicycles and pedestrians are not allowed. Uniform speeds of 3 miles per hour for pedestrians. Bicycle speeds are based on the presence of bike infrastructure and area type classification, with 7 – 9 miles per hour (mph) for facilities without bike lanes, 12-15 mph for facilities with bike lanes and 15 mph for separated bike paths.

The home-based work mode choice model was originally a three-level nested choice model in the BAYCAST model set (See Figure 5.4). Trips are first split into motorized modes, bicycle and walk-only modes. Motorized trips are then split into drive alone, shared ride 2, shared ride 3+ and transit. Lastly, transit trips are split into transit with walk access versus transit with auto access. For application in the SVRT project, a lower-level transit submode nest was added to split walk-access to transit into the walk-access to heavy rail, commuter rail, light rail, express bus and local bus. In addition, the drive-access to transit nest was further stratified to include a lower level nest that splits out drive-access to park-and-ride access and kiss-and-ride access. Market segmentation into the HBW mode choice model is zone-to-zone trips by AO level (3) by household income quartile level (4). Where the auto ownership is zero, work trips are prohibited from taking the drive alone or transit-auto access modes. Coefficients for the HBW mode choice model are shown in Table 5.12. The home-based work mode choice model includes variables about tripmaker demographics (auto ownership, income, household size, workers in the household); trip characteristics (travel time and trip cost); and density; "dummy" variables to represent high bicycle commute shares in Stanford, Palo Alto and Berkeley; and "dummy" variables for regional "core" zones in the San Francisco financial district.

**Figure 5.4 Home-Based Work Mode Choice**



## Table 5.12 Home-based Work Mode Choice Coefficients

| Drive Alone Auto | Shared Ride 2 Person Auto | Shared Ride 3+ Person Auto | Transit Auto-Access | Transit Walk-Access | Bike | Walk | Variable | Coefficient | t-Stat (MTC BAYCAST) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| X | | | | | | | Constant | -9.234 | (4.0) |
| | X | | | | | | Constant | -13.310 | (4.1) |
| | | X | | | | | Constant | -13.780 | (4.1) |
| | | | X | | | | Constant | -12.250 | (4.6) |
| | | | | X | | | Constant | -10.380 | (4.1) |
| | | | | | X | | Constant | -8.268 | (12.4) |
| | | | | | X | | LnEmpDi | 0.3243 | (2.2) |
| | | | X | X | | | LnEmpDj | 0.5461 | (3.3) |
| X | | | | | | | Veh/HH | 1.2240 | (4.5) |
| | X | | | | | | Veh/HH | 0.9023 | (4.2) |
| | | X | | | | | Veh/HH | 0.9357 | (4.2) |
| | X | | | | | | Single VHH | 0.8370 | (2.9) |
| | | | X | | | | Veh/HH | 0.5697 | (3.1) |
| | | | | X | | | No VHH | 0.5501 | (1.4) |
| X | | | | | | | Workers/HH | -0.2454 | (2.3) |
| | X | | | | | | Multi-Wrkr/HH | -0.9297 | (3.0) |
| X | | | | | | | Persons/HH | -0.3099 | (3.6) |
| X | | | | | | | Income Leg1 | 5.878E-05 | (2.0) |
| | X | X | | | | | Income Leg1 | 5.049E-05 | (1.7) |
| X | X | X | X | X | X | | IVTT | -0.03326 | (4.3) |
| | | | X | X | | | Wait | -0.05233 | (3.1) |
| X | X | X | X | X | | | Walk | -0.09305 | (2.2) |
| X | X | X | X | X | | | Cost | -0.002067 | (2.6) |
| | | | | | X | | Stanfordj | 2.09 | (3.0) |
| | | | | | X | | Palo Altoj | 1.584 | (2.3) |
| | | | | | X | | Berkeleyj | 1.01 | (1.5) |
| X | | | | | | | Corej | -1.086 | (2.7) |
| | | | X | | | | Corej | 1.147 | (3.3) |
| | | | | | | X | LnWalkTime | -2.137 | (13.5) |
| | | | | | | X | LnEmpDj | 0.1418 | (2.1) |
| | | | X | X | | | Theta (Transit) | 0.7194 | (2.2) |
| X | X | X | X | X | | | Theta (Motor) | 0.9208 | (0.6) |
| | | | X | X | | | Theta (Submode) | 0.6835 | NA |
| **Value of Time (IVTT/Cost * .60)** | | | | | | | | **$9.65** | |
| **Ratio of Wait/IVTT** | | | | | | | | **1.57** | |
| **Ratio of Walk/IVTT** | | | | | | | | **2.80** | |

### 5.4.1 Home-based Work Mode Choice Model Calibration

The home-based work mode choice models were recalibrated to match year 2000 Census Journey to Work data mode shares for the primary modes of drive-alone, 2 person carpool, 3+ person carpool, transit, walk and bicycle modes. Transit submode calibration target values were based on shares used in the recent model calibration work done for the BART extension to Silicon Valley model calibration for transit walk-access and transit drive-access supplemented with the most recent transit on-board survey data from Caltrain (2000) and BART (1998) for submode walk-access market shares. Calibration of the home-based work constants follow methodologies recommended by FTA, which considered the calibration of regional mode choice constants with no stratification of transit submode walk-access or drive-access constants by income quartile. Transit access target values were calculated based on data summaries from the MTC BATS 2000 trip survey file (specifically, by tabulating the vehicle occupancy for access and egress to transit) in addition to data developed from the observe transit surveys. The final comparison of calibration target values to model estimated trips by mode are provided in Tables 5.13 and 5.14.

The regional constant calibration results for home-based work trips are summarized in Table 5.15. The results of the calibrated constants summarized in Table 5.15 indicate that relative to walk-to-local bus submodes, heavy rail (BART), commuter rail and light rail all offer a rail travel time ‘bonus’ of + 8 minutes, +16 minutes and +10 minutes, respectively. This implies that all else being equal, there is a perceived advantage for persons to take rail modes over local bus modes expressed in equivalent minutes. These calibrated travel time bonuses, excepting commuter rail, are within the FTA recommended limit of 15 minutes equivalent travel time bonus.  For the commuter rail mode, after transit assignment validation is started, this bonus will be re-examined and likely reduced to a 15 minute maximum.

The overall characteristics and trends of the home-based work constants when shown in a graph appear to be reasonable, as shown on Figures 5.6 and 5.7. The constants for both the upper-level choices of drive-alone, shared ride, transit walk and drive access, bicycle and walk in Figure 5.7 and the transit submode choices in Figure 5.7 show reasonable patterns across income quartiles.

### 5.4.2 Home-based Work Mode Choice Model Calibration - Conclusions

The results of the home-based work mode choice calibration yield promising results overall, as the calibrated constants are not overly large and the calibrated rail travel time bonus is within FTA recommendations. However, it should be noted that the walk modes are overestimated after the calibration by approximately 35 percent.

# Table 5.13 Home-based Work Mode Choice Trips by Mode, Observed

**Observed 2000**

| Mode | HBW IQ1 | HBW IQ1 | HBW IQ2 | HBW IQ2 | HBW IQ3 | HBW IQ3 | HBW IQ4 | HBW IQ4 | HBW ALL | Observed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | % | | % | | % | | % | | % |
| Drive Alone | 354,024 | 59.7% | 694,267 | 68.6% | 1,158,932 | 72.7% | 1,537,221 | 75.9% | 3,744,444 | 71.7% |
| SR 2 | 60,212 | 10.2% | 107,921 | 10.7% | 162,171 | 10.2% | 194,787 | 9.6% | 525,091 | 10.1% |
| SR 3+ | 21,971 | 3.7% | 38,728 | 3.8% | 55,122 | 3.5% | 61,466 | 3.0% | 177,287 | 3.4% |
| Transit Walk | 85,903 | 14.5% | 94,696 | 9.4% | 109,574 | 6.9% | 101,877 | 5.0% | 392,050 | 7.5% |
| Transit Auto | 5,145 | 0.9% | 22,974 | 2.3% | 52,270 | 3.3% | 70,851 | 3.5% | 151,240 | 2.9% |
| Bike | 12,520 | 2.1% | 12,934 | 1.3% | 21,181 | 1.3% | 17,831 | 0.9% | 64,466 | 1.2% |
| Walk | 52,966 | 8.9% | 39,906 | 3.9% | 35,477 | 2.2% | 40,030 | 2.0% | 168,379 | 3.2% |
| | | | | | | | | | | |
| Walk to BART | 20,666 | 3.5% | 26,916 | 2.7% | 27,111 | 1.7% | 31,213 | 1.5% | 105,906 | 2.0% |
| Walk to Commuter Rail | 1,369 | 0.2% | 2,487 | 0.2% | 3,378 | 0.2% | 3,806 | 0.2% | 14,431 | 0.3% |
| Walk to LRT | 14,177 | 2.4% | 22,844 | 2.3% | 14,154 | 0.9% | 10,416 | 0.5% | 67,647 | 1.3% |
| Walk to Express | 4,651 | 0.8% | 6,130 | 0.6% | 5,285 | 0.3% | 5,073 | 0.3% | 21,139 | 0.4% |
| Walk to Local | 41,679 | 7.0% | 38,507 | 3.8% | 55,359 | 3.5% | 47,383 | 2.3% | 182,928 | 3.5% |
| Park-and-Ride | 3,597 | 0.6% | 17,778 | 1.8% | 41,691 | 2.6% | 60,779 | 3.0% | 123,845 | 2.4% |
| Kiss-and-Ride | 1,548 | 0.3% | 5,196 | 0.5% | 10,579 | 0.7% | 10,072 | 0.5% | 27,395 | 0.5% |
| | | | | | | | | | | |
| ALL | 592,741 | 100.0% | 1,011,426 | 100.0% | 1,594,727 | 100.0% | 2,024,063 | 100.0% | 5,222,957 | 100.0% |

## Table 5.14 Home-based Work Mode Choice Trips by Mode, Estimated

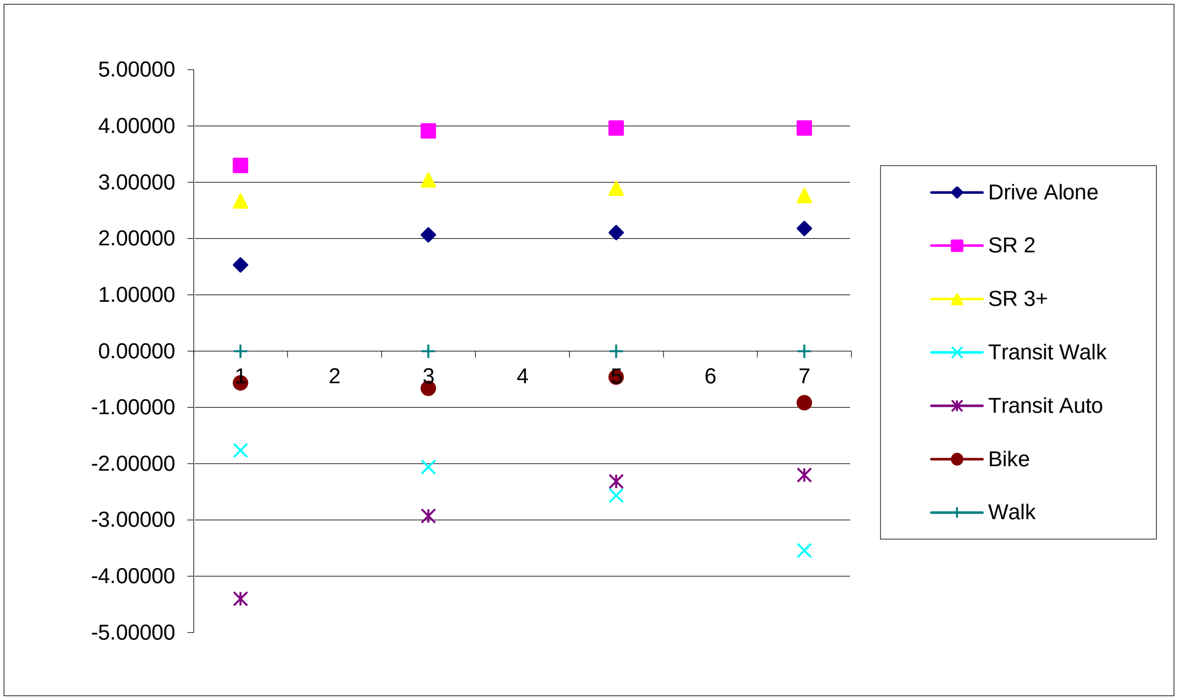
**Estimated 2000**

| Mode | HBW IQ1 | HBW IQ1 | HBW IQ2 | HBW IQ2 | HBW IQ3 | HBW IQ3 | HBW IQ4 | HBW IQ4 | HBW ALL | Modeled | Observed | Modeled/Observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | | % | | % | | % | | % | % | |
| Drive Alone | 341,678 | 60.1% | 685,462 | 67.9% | 1,142,611 | 71.6% | 1,489,883 | 74.8% | 3,659,634 | 70.8% | 71.7% | 98.8% |
| SR 2 | 58,121 | 10.2% | 106,569 | 10.6% | 159,908 | 10.0% | 188,826 | 9.5% | 513,423 | 9.9% | 10.1% | 98.8% |
| SR 3+ | 21,208 | 3.7% | 38,243 | 3.8% | 54,355 | 3.4% | 59,587 | 3.0% | 173,392 | 3.4% | 3.4% | 98.9% |
| Transit Walk | 83,640 | 14.7% | 93,801 | 9.3% | 108,118 | 6.8% | 98,912 | 5.0% | 384,471 | 7.4% | 7.5% | 99.1% |
| Transit Auto | 4,905 | 0.9% | 22,740 | 2.3% | 51,768 | 3.2% | 68,943 | 3.5% | 148,357 | 2.9% | 2.9% | 99.2% |
| Bike | 12,077 | 2.1% | 12,801 | 1.3% | 20,945 | 1.3% | 17,343 | 0.9% | 63,165 | 1.2% | 1.2% | 99.0% |
| Walk | 46,884 | 8.2% | 50,117 | 5.0% | 58,936 | 3.7% | 68,502 | 3.4% | 224,439 | 4.3% | 3.2% | 134.7% |
| Walk to BART | 25,598 | 4.5% | 26,068 | 2.6% | 29,179 | 1.8% | 22,936 | 1.2% | 103,781 | 2.0% | 2.0% | 99.1% |
| Walk to Commuter Rail | 3,152 | 0.6% | 3,049 | 0.3% | 3,886 | 0.2% | 4,026 | 0.2% | 14,113 | 0.3% | 0.3% | 98.9% |
| Walk to LRT | 9,096 | 1.6% | 14,653 | 1.5% | 20,675 | 1.3% | 21,932 | 1.1% | 66,356 | 1.3% | 1.3% | 99.2% |
| Walk to Express | 3,937 | 0.7% | 4,225 | 0.4% | 5,356 | 0.3% | 7,176 | 0.4% | 20,694 | 0.4% | 0.4% | 99.0% |
| Walk to Local | 41,837 | 7.4% | 45,780 | 4.5% | 48,992 | 3.1% | 42,813 | 2.1% | 179,423 | 3.5% | 3.5% | 99.1% |
| Park-and-Ride | 3,422 | 0.6% | 17,590 | 1.7% | 41,288 | 2.6% | 59,138 | 3.0% | 121,438 | 2.4% | 2.4% | 99.1% |
| Kiss-and-Ride | 1,471 | 0.3% | 5,136 | 0.5% | 10,468 | 0.7% | 9,792 | 0.5% | 26,868 | 0.5% | 0.5% | 99.1% |
| | | | | | | | | | | | | |
| ALL | 568,512 | 100.0% | 1,009,733 | 100.0% | 1,596,641 | 100.0% | 1,991,996 | 100.0% | 5,166,882 | 100.0% | 100.0% | 100.0% |

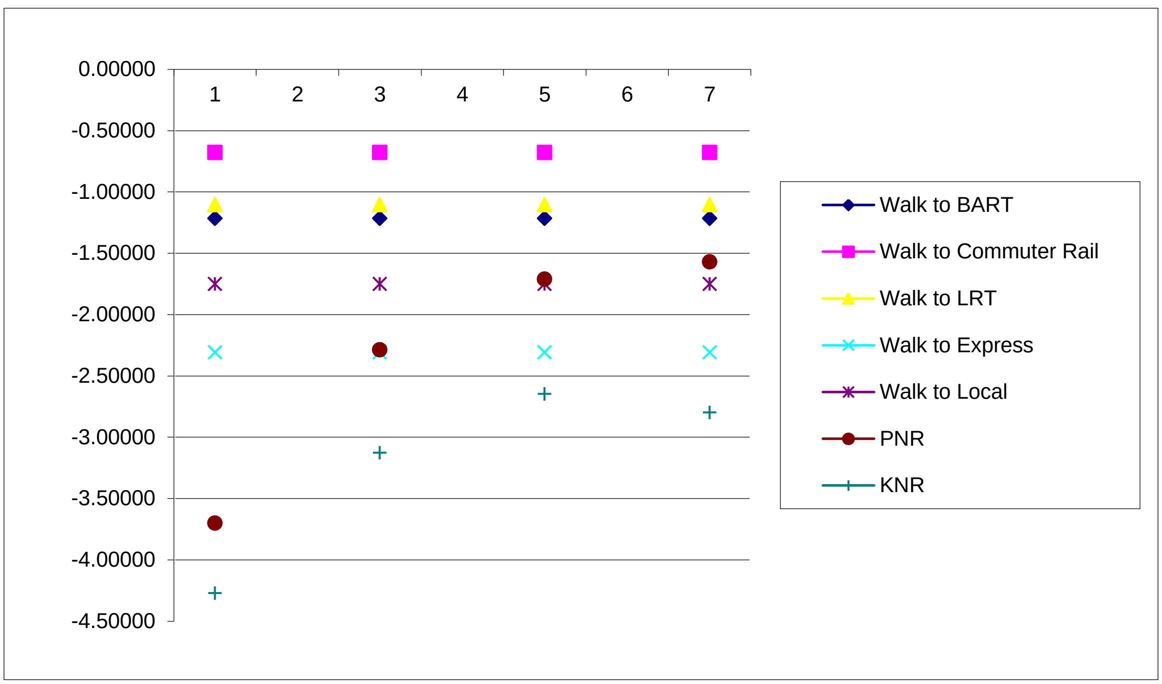
## Table 5.15 Home-based Work Mode Choice Final Constants

| Mode | HBW IQ1 | HBW IQ2 | HBW IQ3 | HBW IQ4 | ALL | IVTT Bonus (minutes) v. Local Bus |
|---|---|---|---|---|---|---|
| | | | | | | |
| Drive Alone | 1.5137 | 2.0994 | 2.1508 | 2.2246 | | |
| SR 2 | 3.2807 | 3.9470 | 4.0088 | 4.0128 | | |
| SR 3+ | 2.6519 | 3.0754 | 2.9450 | 2.8132 | | |
| Transit Walk | -1.8100 | -2.0397 | -2.5208 | -3.5006 | | |
| Transit Auto | -4.3836 | -2.9074 | -2.2879 | -2.1706 | | |
| Bike | -0.5826 | -0.6325 | -0.4261 | -0.8793 | | |
| Walk | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | |
| | | | | | | |
| Walk to BART | -1.2004 | -1.2004 | -1.2004 | -1.2004 | -1.2004 | 8 |
| Walk to Commuter Rail | -0.6577 | -0.6577 | -0.6577 | -0.6577 | -0.6577 | 16 |
| Walk to LRT | -1.0883 | -1.0883 | -1.0883 | -1.0883 | -1.0883 | 10 |
| Walk to Express | -2.2898 | -2.2898 | -2.2898 | -2.2898 | -2.2898 | |
| Walk to Local | -1.7341 | -1.7341 | -1.7341 | -1.7341 | -1.7341 | |
| PNR | -3.6850 | -2.2724 | -1.6925 | -1.5503 | | |
| KNR | -4.2580 | -3.1115 | -2.6290 | -2.7778 | | |

## Figure 5.6 Home-based Work Upper Level Nest Calibration Constants




## Figure 5.7 Home-based Work Lower Level Nest Calibration Constants



## 5.5 Non-Work Mode Choice Model

The trip purposes that comprise non-work trips consist of the following:

- Home-based Shopping/Other – these trips are produced from the home to shop and for essentially personal business trips,
- Home-based Social-Recreational – these trips are produced from the home for social and/or recreational purposes,
- Home-based School trips – there are three types of home-based school trips modeled as separate trip purposes. These trips are made from the home to either grade school, high school or college, and
- Non-home-based – these trips are not produced or attracted at the home-end. Examples of these types of trips would be travel from work to a restaurant during the mid-day, or from shopping to the dry cleaners.

The non-work mode choice models were calibrated by adjusting mode specific constants, using observed travel survey data from the 2000 MTC BATS. At the regional level, the calibration of the non-work mode choice models to year 2000 observed conditions yielded a close match to the mode shares for the most significant non-work travel markets of home-based shop/other, home-based social-recreational and non-home-based. Home-based school calibration yielded a calibration less accurate than the other non-work trips, however, they comprise a smaller share of the overall travel market.

### 5.5.1 Non-Work Mode Choice Model Structure and Model Coefficients

The non-work models follow the same structure as the home-based work models in that they are nested logit models, with a lower-level transit submode nest added to split walk-access to transit into the walk-access to heavy rail, commuter rail, light rail, express bus and local bus. In addition, the original MTC BAYCAST-90 transit nest was further stratified to include a new lower level nest that split drive-access to park-and-ride access and kiss-and-ride access if data were available to support this distinction. Drive to transit was not assumed for the non-home-based and home-based school trips to simplify the choices – only walk to transit is allowed. The mode choice structures for the non-work trips are shown on Figure 5.8 through Figure 5.10. The nesting coefficients applied to the transit access and transit submode nests were borrowed from the home-based work models, applying a nesting coefficient for the transit access nest of 0.7194 and a transit submode nest of 0.6835. Coefficients for the non-work models, by trip purpose, are shown in Table 5.16 through Table 5.21.

**Figure 5.8 Home-Based Shopping Other Mode Choice**

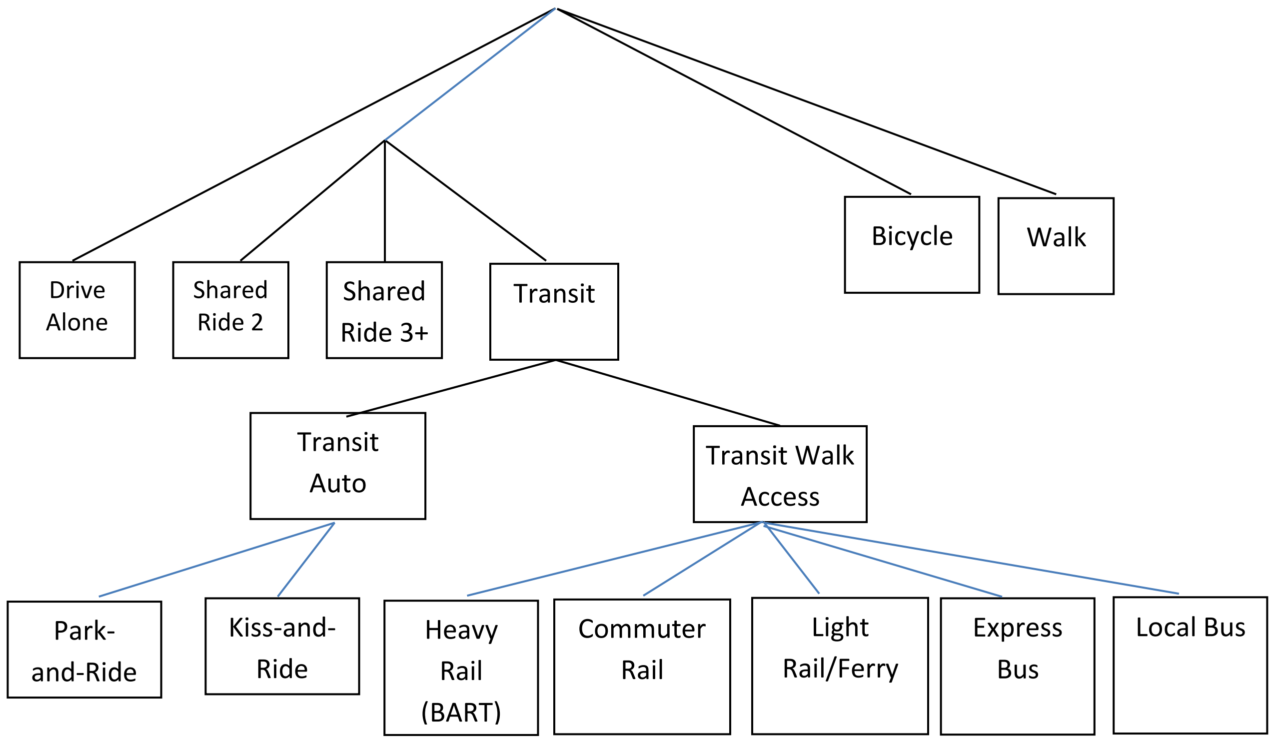


**Figure 5.9 Home-Based Social-Recreational Mode Choice**

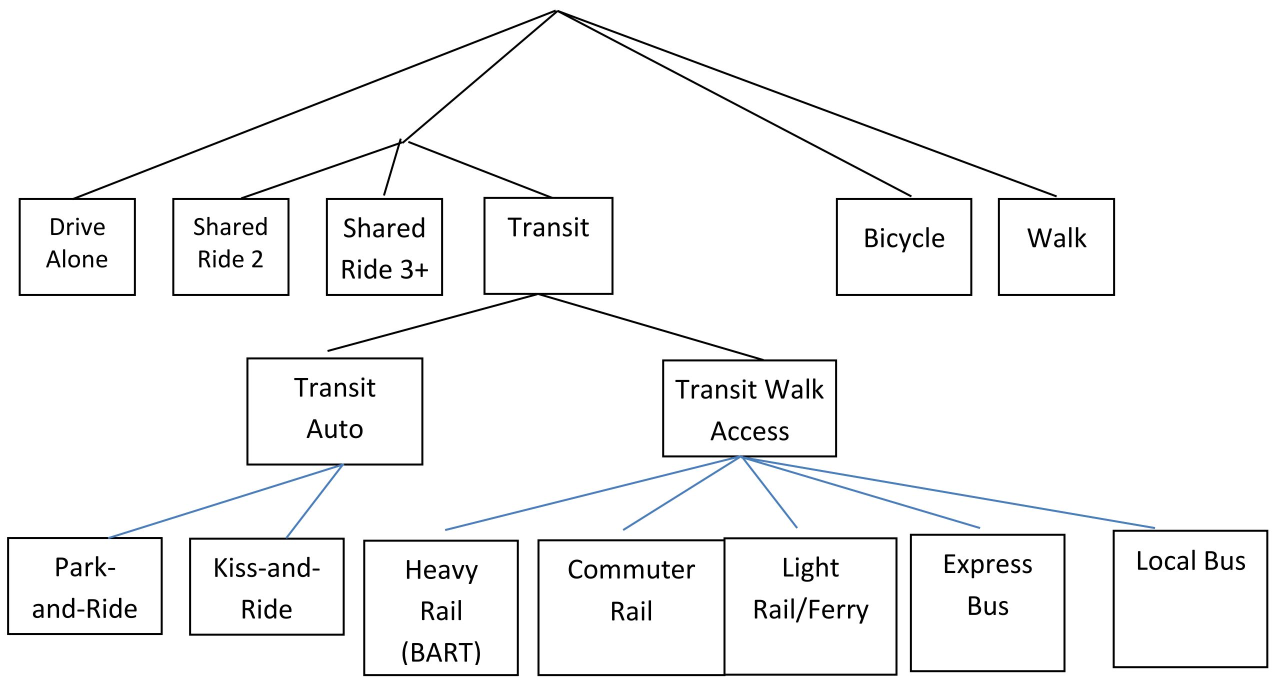
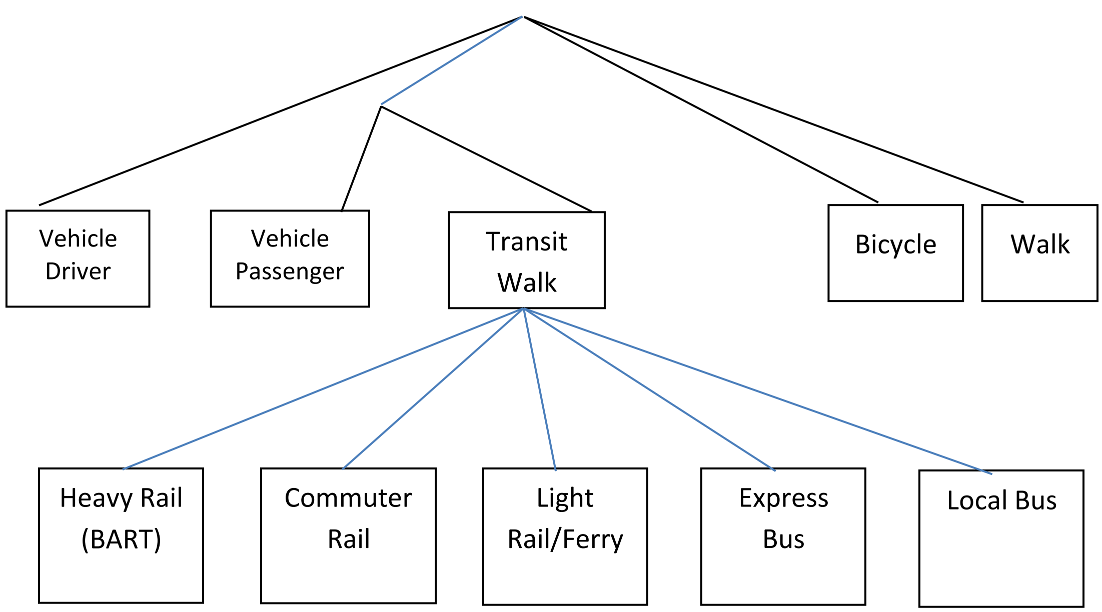



**Figure 5.10 Home-based School and Non-home-based Mode Choice Structures**



## Table 5.16 Home-based Shop/Other Mode Choice Coefficients

| Choice | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DA | SR2 | SR3+ | Transit Walk | Transit Drive | Bike | Walk | Variable Name | Coeff. |
| X | | | | | | | Constant | 0.5495 |
| | X | | | | | | Constant | -0.3612 |
| | | X | | | | | Constant | -2.4860 |
| | | | X | X | | | Constant | -1.7470 |
| | | | | | X | | Constant | -3.9280 |
| | X | | | | | | LnPHH | 0.6635 |
| | | X | | | | | LnPHH | 2.2360 |
| | | | X | | | | Veh/HH | -0.3352 |
| X | | | | | | | LnIncome | 0.1952 |
| | X | | | | | | LnIncome | 0.1118 |
| X | X | X | X | X | X | X | Time (Total) | -0.05815 |
| X | X | X | X | X | | | LnCost | -0.2262 |
| | | | X | X | | | Corej | 2.3750 |
| X | X | X | | | | | LnAreaDeni | -0.4701 |
| | | | | | X | | Stanfordj | 2.488 |
| | | | | | X | | Berkeleyj | 1.630 |
| | | | | | X | | Palo AltoJ | 1.377 |
| X | | | | | | | Zero WHH | -0.2273 |
| | | | X | | | | Zero VHH | 3.2910 |
| | | | | | | X | Zero VHH | 1.7350 |
| X | X | X | X | X | | | Theta (Motor) | 0.4847 |
| | | | X | X | | | Theta (Access) | 0.7194 |
| | | | X | X | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

## Table 5.17 Home-based Social-Recreational Mode Choice Coefficients

| Choice | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DA | SR2 | SR3+ | Transit Walk | Transit Drive | Bike | Walk | Variable Name | Coeff. |
| X | | | | | | | Constant | 1.295 |
| | X | | | | | | Constant | -1.437 |
| | | X | | | | | Constant | -2.486 |
| | | | X | X | | | Constant | 1.703 |
| | | | | | X | | Constant | -3.149 |
| | | X | | | | | LnPHH | 1.8340 |
| | | | X | | | | Veh/HH | -0.7475 |
| | X | | | | | | LnIncome | 0.2305 |
| | | | | | X | | Income | -0.0088.88 |
| X | X | X | X | X | X | | IVTT | -0.02745 |
| X | X | X | X | X | | X | OVTT | -0.06806 |
| X | X | X | X | X | | | LnCost | -1.1600 |
| | | | X | X | | | Corej | 0.9694 |
| | | | X | X | | | LnAreaDeni | 0.3217 |
| | | | | | X | | Stanfordj | 2.2090 |
| | X | X | X | X | | | Theta (Group) | 0.6271 |
| | | | X | X | | | Theta (Access) | 0.7194 |
| | | | X | X | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

**Table 5.18 Non-home-based Mode Choice Coefficients**

| Choice | | | | | | |
|---|---|---|---|---|---|---|
| Vehicle Driver | Vehicle Passenger | Transit Walk | Bike | Walk | Variable Name | Coeff. |
| **X** | | | | | Constant | 2.233 |
| | **X** | | | | Constant | 0.5104 |
| | | **X** | | | Constant | -2.0540 |
| | | | **X** | | Constant | -4.769 |
| **X** | | | | | AreaDeni | -0.0005277 |
| | | | | **X** | AreaDeni | 0.0004173 |
| **X** | **X** | **X** | **X** | | IVTT | -0.03237 |
| | | **X** | | | Wait | -0.07583 |
| **X** | **X** | **X** | | **X** | Walk | -0.07836 |
| **X** | **X** | **X** | | | LnCost | -0.9862 |
| **X** | **X** | **X** | | | Theta (Motor) | -0.6271 |
| | | **X** | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

## Table 5.19 Home-based Grade School Mode Choice Coefficients

| Choice | | | | | |
|---|---|---|---|---|---|
| Vehicle Passenger | Transit | Bike | Walk | Variable Name | Coeff. |
| X | | | | Constant | 2.6250 |
| | X | | | Constant | 7.3003 |
| | | X | | Constant | -3.1550 |
| | X | | X | PHH^3 | 0.004436 |
| | X | | | Rurali | 1.5440 |
| X | | | | Income (000s) | 0.009757 |
| X | X | X | | IVTT | -0.05855 |
| X | X | | X | OVTT | -0.06384 |
| X | X | | | LnCost | -1.93000 |
| | X | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

## Table 5.20 Home-based High School Mode Choice Coefficients

| Choice | | | | | | |
|---|---|---|---|---|---|---|
| Vehicle Driver | Vehicle Passenger | Transit | Bike | Walk | Variable Name | Coeff. |
| **X** | | | | | Constant | -0.6729 |
| | **X** | | | | Constant | 0.1929 |
| | | **X** | | | Constant | 2.9550 |
| | | | **X** | | Constant | -3.5240 |
| **X** | | | | | Veh/HH | 3.5580 |
| | **X** | | | | Veh/HH | 0.5994 |
| **X** | | | | | Pers/HH | -1.5000 |
| | | **X** | | | Net ResDensI | 0.1442 |
| **X** | **X** | **X** | **X** | | IVTT | -0.03228 |
| **X** | **X** | **X** | | **X** | OVTT | -0.03463 |
| **X** | **X** | **X** | | | LnCost | -2.0340 |
| | **X** | **X** | | | Theta (Group) | 0.2583 |
| | | **X** | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

**Table 5.21 Home-based College Mode Choice Coefficients**

| Choice | | | | | | |
|---|---|---|---|---|---|---|
| Vehicle Driver | Vehicle Passenger | Transit | Bike | Walk | Variable Name | Coeff. |
| X | | | | | Constant | -1.461 |
| | X | | | | Constant | -5.506 |
| | | X | | | Constant | -1.4480 |
| | | | X | | Constant | -3.3980 |
| X | | | | | Veh/HH | 0.7728 |
| X | | | | | Pers/HH | -0.2638 |
| X | | | | | Net ResDensI | -0.3973 |
| | | | X | | STANFORD TAZ | 3.216 |
| | | | X | | PALO ALTO TAZ | 2.668 |
| | | | X | | BERKELEY TAZ | 1.711 |
| X | X | X | X | | IVTT | -0.02731 |
| X | X | X | | X | OVTT | -0.03923 |
| X | X | X | | | LnCost | -0.6920 |
| | X | X | | | Theta (Group) | 0.5302 |
| | | X | | | Theta (Submode) | 0.6835 |

Source: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90). Technical Summary MTC June 1997

Note: Theta for Access and Submode from VTA

### 5.5.2 Non-work Mode Choice Model Calibration

The non-work mode choice models were recalibrated to match year 2000 mode shares from the MTC BATS 2000 regional survey observations for non-work trip purposes, for the primary modes of drive-alone, 2 person carpool, 3+ person carpool, transit, walk and bicycle modes. For non-home-based and home-based school trips, auto modes were estimated for vehicle driver and vehicle passenger modes. Transit submode calibration target values were based on shares used in the recent VTA's model calibration work done for the BART extension to Silicon Valley project for transit walk-access and transit drive-access supplemented with the most recent transit on-board survey data from Caltrain (2000) and BART (1998) for submode walk-access market shares. Transit walk and drive access target values were calculated based on data summaries from the MTC BATS 2000 trip survey file (again, by tabulating the vehicle occupancy for access and egress to transit as was done for the home-based work trips) in addition to data developed from the observed transit surveys. Transit submode targets for BART and commuter rail were adjusted to match data from the transit on-board surveys, as the rail submode totals from the MTC BATS survey for BART and Caltrain were much higher than the total boardings from the actual transit surveys. The final comparison of calibration target values to model estimated trips by mode are provided in Table 5.22 through Table 5.26. In particular, the home-based shopping/other, home-based social/recreation and non-home-based trips have a very good agreement between estimated and observed trips by mode. Home-based school trips show a less favorable comparison of observed to estimated trips, however, it should be noted that school trips comprise a smaller proportion of the total non-work trip market in total person trips.

The regional constant calibration results for non-work trips are summarized in Table 5.26. The results of the calibrated constants summarized in Table 5.26 actually show wide variation in the relative travel time bonus of the transit submodes relative to local bus, and show patterns less well-behaved then the results from the home-based work calibration. For example, for home-based shopping/other trips, heavy rail (BART), commuter rail and light rail all offer a rail travel time 'bonus' of + 1 minutes, +15 minutes and +0 minutes, respectively, relative to local bus. However, for home-based social/recreational trips, heavy rail (BART), commuter rail and light rail all offer a rail travel time 'bonus' of -7 minutes, +9 minutes and +5 minutes, respectively, relative to local bus. And finally, non-home-based trips, heavy rail (BART), commuter rail and light rail all offer a rail travel time 'bonus' of + 22 minutes, +19 minutes and +10 minutes, respectively, relative to local bus. While it is difficult to determine a reason for the variation, particularly for the -7 minutes for BART for the home-based social/recreational trips, in general, fixed guideway modes tend to offer a travel time advantage over the local bus mode, which is the general expectation given the implied reliability and perceived comfort of the guideway transit modes.

### 5.5.3 Non-work Mode Choice Model Calibration – Conclusions

As with the home-based work trips, the results of the non-work mode choice calibration yield promising results overall, and with the exception of a few choices in the school trip purposes, the calibrated constants are not overly large. In addition, the calibrated rail travel time bonus is within FTA recommendations for all but BART and commuter rail for the non-home-based trip purpose.

**Table 5.22 Home-based Shopping/Other Trips by Mode, Observed versus Estimated**

| Mode | Observed | Observed % | Estimated | Estimated % | Observed/ Estimated |
|---|---|---|---|---|---|
| Drive Alone | 2,099,075 | 39.2% | 2,066,336 | 39.2% | 99.9% |
| Shared Ride 2 Person | 1,432,357 | 26.8% | 1,410,029 | 26.8% | 99.9% |
| Shared Ride 3+ Person | 979,793 | 18.3% | 964,523 | 18.3% | 99.9% |
| All Transit | 184,129 | 3.4% | 180,570 | 3.4% | 100.3% |
| Transit Walk-access | 168,150 | 3.1% | 164,675 | 3.1% | 100.4% |
| Transit Drive-access | 15,979 | 0.3% | 15,895 | 0.3% | 98.9% |
| Bike | 76,269 | 1.4% | 75,044 | 1.4% | 100.0% |
| Walk | 580,867 | 10.9% | 568,583 | 10.8% | 100.5% |
| Other | | | | | |
| All | 5,352,491 | 100.0% | 5,265,086 | 100.0% | 100.0% |
| | | | | | |
| Walk to BART | 21,722 | 0.4% | 21,553 | 0.4% | 99.1% |
| Walk to Commuter Rail | 1,553 | 0.0% | 1,535 | 0.0% | 99.5% |
| Walk to LRT | 16,968 | 0.3% | 16,822 | 0.3% | 99.2% |
| Walk to Express Bus | 7,796 | 0.1% | 7,721 | 0.1% | 99.3% |
| Walk to Local Bus | 120,111 | 2.2% | 117,030 | 2.2% | 101.0% |
| Park-and-ride | 12,903 | 0.2% | 12,874 | 0.2% | 98.6% |
| Kiss-and-ride | 3,076 | 0.1% | 3,012 | 0.1% | 100.5% |

**Table 5.23 Home-based Social-Recreational Trips by Mode, Observed versus Estimated**

| Mode | Observed | Observed % | Estimated | Estimated % | Observed/ Estimated |
|---|---|---|---|---|---|
| Drive Alone | 981,885 | 27.4% | 1,020,340 | 28.3% | 96.8% |
| Shared Ride 2 Person | 926,804 | 25.9% | 963,091 | 26.7% | 96.8% |
| Shared Ride 3+ Person | 1,115,843 | 31.2% | 1,159,443 | 32.2% | 96.8% |
| All Transit | 110,839 | 3.1% | 114,367 | 3.2% | 97.5% |
| Transit Walk-access | 100,400 | 2.8% | 103,660 | 2.9% | 97.5% |
| Transit Drive-access | 10,439 | 0.3% | 10,706 | 0.3% | 98.1% |
| Bike | 56,443 | 1.6% | 59,188 | 1.6% | 96.0% |
| Walk | 389,351 | 10.9% | 286,943 | 8.0% | 136.5% |
| | | | | | |
| All | 3,581,166 | 100.0% | 3,603,371 | 100.0% | 100.0% |
| | | | | | |
| Walk to BART | 6,365 | 0.2% | 6,751 | 0.2% | 94.9% |
| Walk to Commuter Rail | 1,815 | 0.1% | 1,926 | 0.1% | 94.8% |
| Walk to LRT | 15,929 | 0.4% | 16,922 | 0.5% | 94.7% |
| Walk to Express Bus | 1,815 | 0.1% | 1,926 | 0.1% | 94.8% |
| Walk to Local Bus | 74,465 | 2.1% | 76,103 | 2.1% | 98.5% |
| Park-and-ride | 8,206 | 0.2% | 8,319 | 0.2% | 99.2% |
| Kiss-and-ride | 2,233 | 0.1% | 2,374 | 0.1% | 94.6% |

**Table 5.24 Non-home-based Trips by Mode, Observed versus Estimated**

| Mode | Observed | Observed % | Estimated | Estimated % | Observed/ Estimated |
|---|---|---|---|---|---|
| Vehicle Driver | 2,740,387 | 58.9% | 2,763,612 | 59.4% | 99.2% |
| Vehicle Passenger | 1,022,623 | 22.0% | 1,031,140 | 22.2% | 99.2% |
| All Transit | 213,128 | 4.6% | 215,415 | 4.6% | 98.9% |
| Bike | 48,938 | 1.1% | 49,171 | 1.1% | 99.5% |
| Walk | 629,224 | 13.5% | 594,962 | 12.8% | 105.8% |
| | | | | | |
| All | 4,654,300 | 100.0% | 4,654,300 | 100.0% | 100.0% |
| | | | | | |
| Walk to BART | 39,899 | 0.9% | 39,898 | 0.9% | 100.0% |
| Walk to Commuter Rail | 3,492 | 0.1% | 3,496 | 0.1% | 99.9% |
| Walk to LRT | 26,940 | 0.6% | 26,905 | 0.6% | 100.1% |
| Walk to Express Bus | 7,271 | 0.2% | 7,278 | 0.2% | 99.9% |
| Walk to Local Bus | 138,150 | 3.0% | 137,804 | 3.0% | 100.3% |

**Table 5.25 Home-based School Trips by Mode, Observed versus Estimated**

| **Home-based College** | | | | | |
|---|---|---|---|---|---|
| **Mode** | **Observed** | **Observed %** | **Estimated** | **Estimated %** | **Observed/Estimated** |
| Vehicle Driver | 336,732 | 74.1% | 272,896 | 58.9% | 125.8% |
| Vehicle Pasenger | 49,870 | 11.0% | 42,409 | 9.2% | 119.9% |
| Transit | 74,440 | 16.4% | 58,533 | 12.6% | 129.6% |
| Bike | 10,416 | 2.3% | 10,176 | 2.2% | 104.3% |
| Walk | 57,566 | 12.7% | 137,857 | 29.8% | 42.6% |
| All | 454,584 | 100.0% | 463,337 | 100.0% | 100.0% |
| **Home-based High School** | | | | | |
| **Mode** | **Observed** | **Observed %** | **Estimated** | **Estimated %** | **Observed/Estimated** |
| Vehicle Driver | 68,343 | 14.8% | 62,226 | 13.4% | 109.8% |
| Vehicle Passenger | 256,007 | 55.3% | 237,811 | 51.4% | 107.7% |
| Transit | 48,070 | 10.4% | 52,034 | 11.2% | 92.4% |
| Bike | 5,609 | 1.2% | 66,985 | 14.5% | 8.4% |
| Walk | 84,819 | 18.3% | 43,792 | 9.5% | 193.7% |
| All | 462,848 | 100.0% | 462,848 | 100.0% | 100.0% |
| **Home-based Grade School** | | | | | |
| **Mode** | **Observed** | **Observed %** | **Estimated** | **Estimated %** | **Observed/Estimated** |
| Vehicle Driver | 0 | 0.0% | 0 | 0.0% | 0.0% |
| Vehicle Passenger | 1,042,168 | 70.5% | 1,044,391 | 70.7% | 99.8% |
| Transit | 90,433 | 6.1% | 162,249 | 11.0% | 55.7% |
| Bike | 28,759 | 1.9% | 26,312 | 1.8% | 109.3% |
| Walk | 316,183 | 21.4% | 244,590 | 16.6% | 129.3% |
| All | 1,477,542 | 100.0% | 1,477,542 | 100.0% | 100.0% |

## Table 5.26 Non-work Mode Choice Constants

| Mode | Home-based Shop/Other | Travel Time Bonus | Home-based Social Recreational | Travel Time Bonus |
|---|---|---|---|---|
| Drive Alone | -0.17250 | | 0.30386 | |
| SR 2 | 0.67729 | | 0.21099 | |
| SR 3+ | 1.97792 | | 1.67123 | |
| Transit Walk | -1.13135 | | -0.23152 | |
| Transit Auto | 0.61840 | | -0.86661 | |
| Bike | 0.73596 | | -0.41389 | |
| Walk | 0 | | 0 | |
| | | HBSHOP/OTHER | | HBSR |
| Walk to BART | 0.12395 | +1 | -0.71474 | -7 |
| Walk to Commuter Rail | 1.24012 | +15 | 0.94455 | +9 |
| Walk to LRT | -0.03096 | 0 | 0.48451 | +5 |
| Walk to Express | 0.81711 | +10 | -1.34725 | -14 |
| Walk to Local | 0 | | 0 | |
| PNR | 0 | | 0 | |
| KNR | -0.99118 | | -0.85449 | |

| Mode | Non-home-based | Travel Time Bonus | Home-based Grade School | Home-based High School | Home-based College |
|---|---|---|---|---|---|
| Vehicle Driver | -0.21007 | | NA | 1.33926 | 5.45558 |
| Vehicle Passenger | 0.83201 | | 0.29576 | 2.13442 | 6.03074 |
| Transit | 1.98608 | | -10.14806 | -8.44962 | 4.38209 |
| Bike | 0.33608 | | -0.88420 | -28.04515 | 1.88392 |
| Walk | 0 | | 0 | 0 | 0 |
| | | NHB Time Bonus, | | | |
| Walk to BART | 1.04417 | +22 | NA | NA | NA |
| Walk to Commuter Rail | 0.88665 | +19 | NA | NA | NA |
| Walk to LRT | 0.45551 | +10 | NA | NA | NA |
| Walk to Express | -0.04144 | -1 | NA | NA | NA |
| Walk to Local | 0 | | NA | NA | NA |

# 6.0 Model Validation

With the completion of the 2000 calibration, the model was applied using year 2010 network and socioeconomic data inputs, and the model estimates were compared to observed count data. The process of validation is typically applied to the vehicle assignments and transit assignments by comparing the model volumes to observed data summarized at an appropriate scale. In this instance, vehicle volumes from the models were compared to observed vehicle volumes at 16 screenline locations. Figures 6.2 through 6.6 show the location of each of the 16 screenlines for the cordon and for the screenlines in each Planning Area. Transit model estimates were validated by comparing observed boardings summarized for each operator.

## 6.1 Validation Data

For the current model update, the data used to validate the year 2010 model estimates were from a variety of sources and were comprised of roadway traffic counts, transit boardings, BART station ons and offs and bicycle count data. Data sources include:

- Year 2010 households by number of workers and auto ownership from the American Community Survey (ACS),
- Year 2010 Journey to Work County to County worker flows from ACS, and
- Year 2010 Journey to Work by mode of travel, County-level and regional-level from ACS.

### 6.1.1 Traffic Count Data

The Alameda CTC provided a comprehensive database of traffic count data compiled from a variety of different sources and years, which were subsequently summarized into the 16 county screenlines and segmented by time of day. Traffic counts were also compiled from a variety of different years (2008 to 2012) to provide the most reasonable estimate for a comprehensive 2010 base year. Traffic counts on the arterials that crossed the county screenlines were from the Alameda CTC local jurisdiction 24-hour screenline count program. Traffic counts on the freeways that crossed the screenlines were obtained from Caltrans or from PEMS databases. Once the counts by hour for each screenline were compiled, Alameda CTC staff developed the counts for the appropriate validation time periods, as follows:

1. AM Peak Hour (7:30 to 8:30 AM)
2. PM Peak Hour (4:30 to 5:30 PM)
3. AM Peak period (6 to 10 AM)
4. PM Peak Period (3 to 7 PM)
5. Daily 24-Hour

### 6.1.2 Transit Validation Data

Average weekday transit boardings by route were provided by each Alameda County transit operator for purposes of validation, including AC Transit, LAVTA, Union City Transit, Emery-go-Round, Capitol Corridor, ACE and the East Bay Ferry system. Additional 2010 transit boarding data for adjacent transit operators (MUNI, Caltrain, County Connection, WestCat, SamTrans and VTA) was obtained from MTC 2010 model validation documentation for adjacent transit operators to validate adjacent operators. In addition, BART provided year 2010 station ons and offs, as well as BART park-and-ride lot spaces.

### 6.1.3 Bicycle Validation Data

Bicycle count data was provided by Alameda CTC, and consisted of PM peak hour counts collected by both Alameda CTC and MTC. Bicycle counts at 63 intersections located throughout Alameda County were summarized for validation. Inbound bicycle volumes from each leg of the intersection was tabulated as the value for validation. The PM peak hour count data were expanded to represent a daily bicycle count estimate based on factors from fixed trail counts obtained by Alameda CTC staff.

### 6.2 Roadway Screenline Validation Results

A comparison of the vehicle volumes estimated by the models to the observed counts was performed at individual screenlines for each of the five time periods. The results of the comparisons to the different time periods are provided in Tables 6.1 through 6.5 for the AM peak hour, PM peak hour, AM 4-hour peak period, PM 4-hour peak period and daily conditions.

#### 6.2.1 Validation Criteria

The validation criteria used for the vehicle assignments were the same as those used in the previous model update project, and were based on error tolerances recommended by FHWA for screenline volumes. These error ranges are based on a volume value and the critieria are noted for each screenline location, as the value varies depending on the volume. In addition to the FHWA error ranges, the screenline validation performance is assessed by comparing the percent error for each screenline. While no specific criteria is applied, a rule of thumb would be that a majority of the screenlines be within 15 percent error.

**Figure 6.1 FHWA Validation Error Curve**

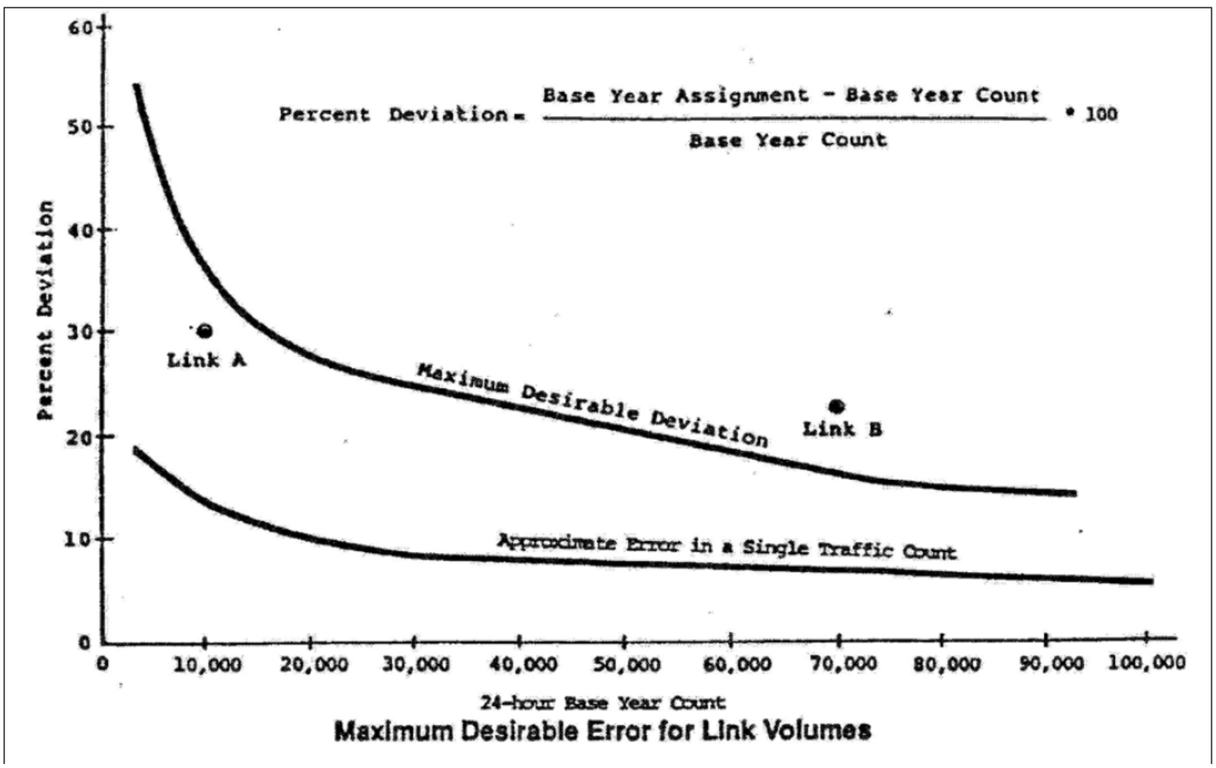


**Figure 6.2 Cordon Screenline 1**

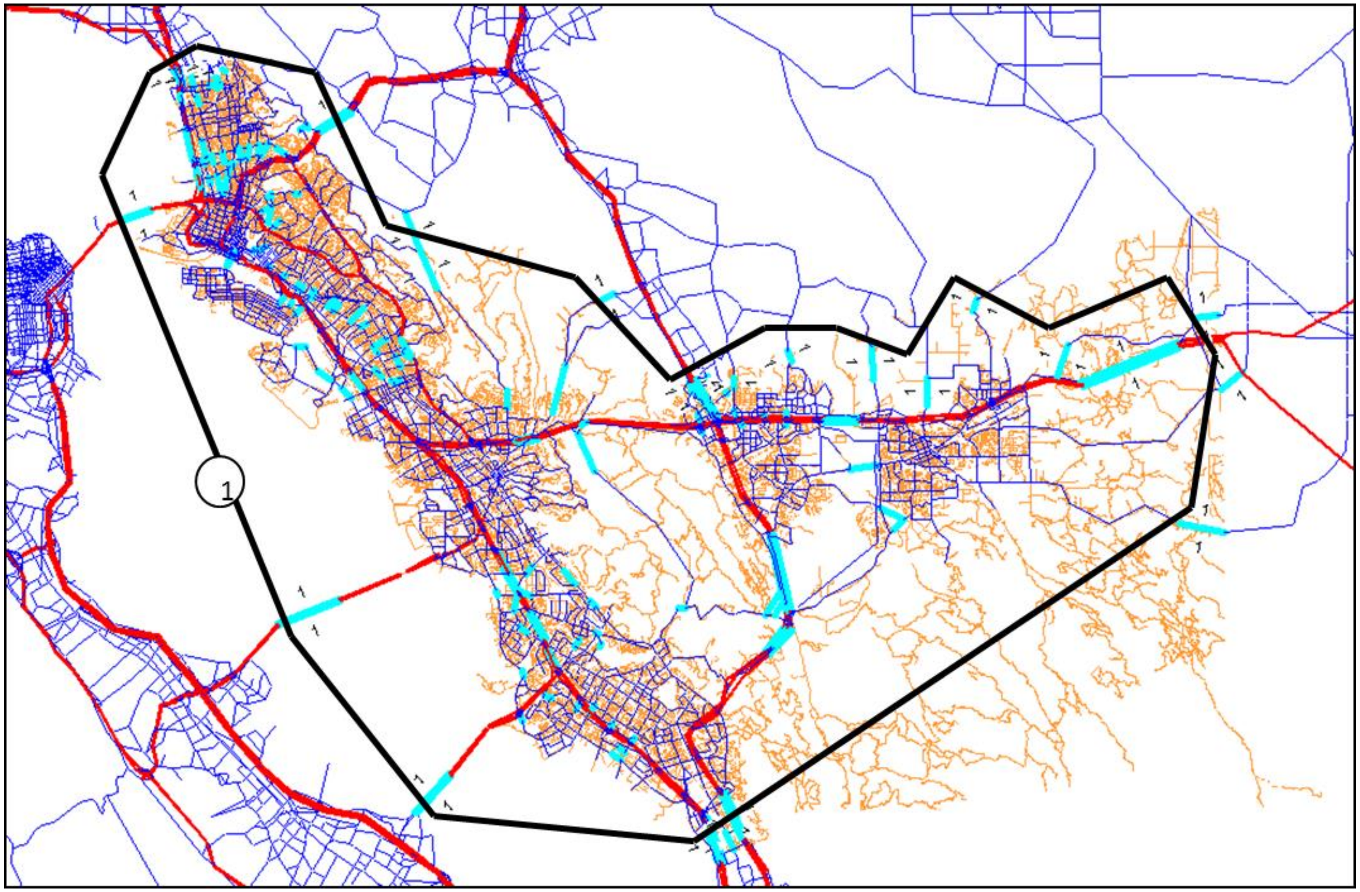


**Figure 6.3 Planning Area 1 Screenlines**

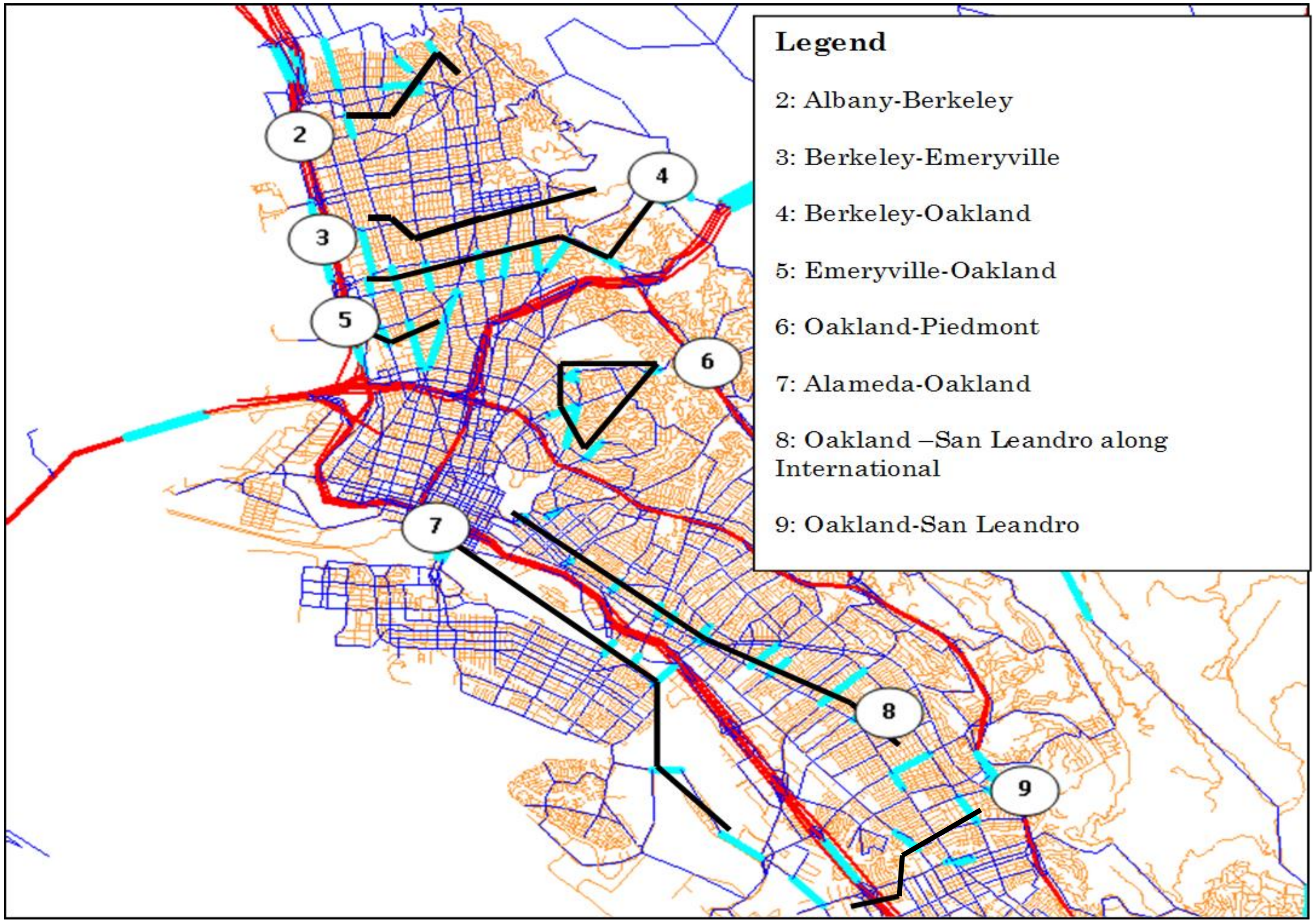


**Figure 6.4 Planning Area 2 Screenlines**

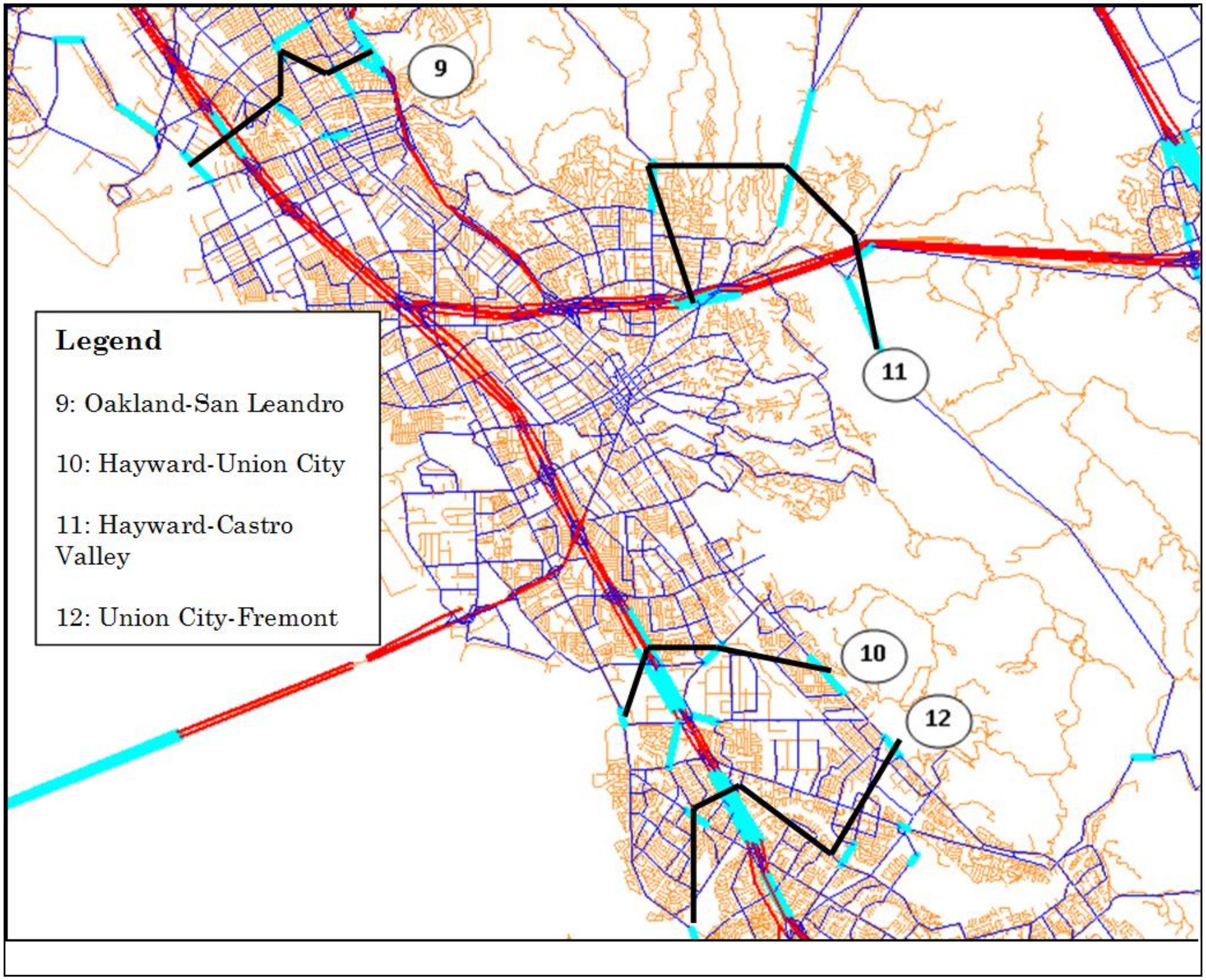


**Figure 6.5 Planning Area 3 Screenlines**

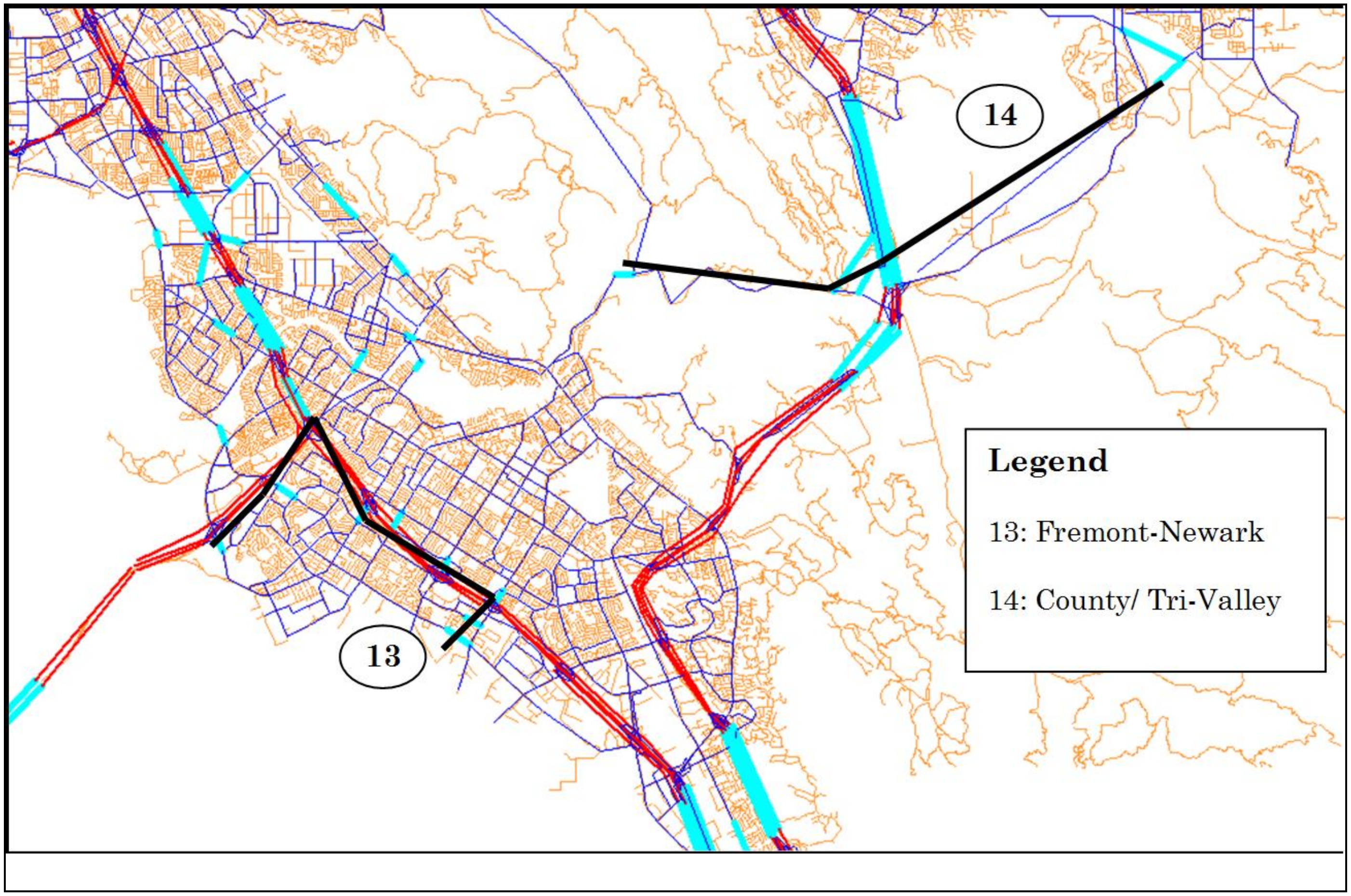
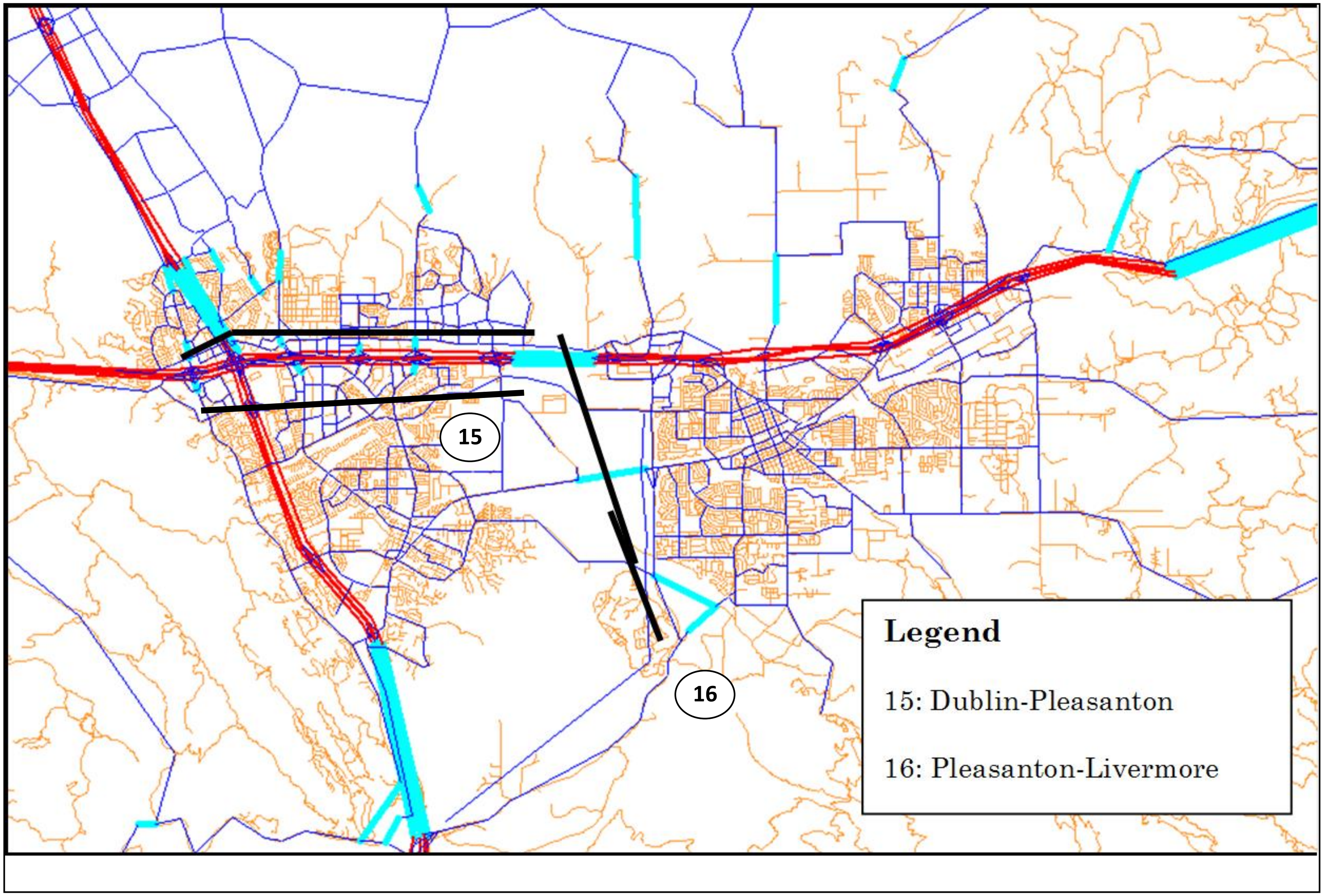


**Figure 6.6 Planning Area 4 Screenlines**



### 6.2.2 Screenline Validation Results

For the AM peak hour shown in Table 6.1, only 1 screenline did not meet the FHWA validation criteria, however, overall model volumes at the screenlines are within 2 percent error of the observed volumes. The majority of screenlines, 81 percent, are within 15 percent of the observed volumes (13 screenlines out of 16).

For the PM peak hour shown in Table 6.2, all screenlines met the FHWA validation criteria and overall model volumes at the screenlines are within 2 percent error of the observed volumes. The majority of screenlines, 75 percent, are within 15 percent of the observed volumes (12 screenlines out of 16).

For the AM peak period shown in Table 6.3, 2 screenlines did not meet the FHWA validation criteria, however, overall model volumes at the screenlines are within 3 percent error of the observed volumes. The majority of screenlines, 88 percent, are within 15 percent of the observed volumes (14 screenlines out of 16).

For the PM peak period shown in Table 6.4, all screenlines met the FHWA validation criteria and overall model volumes at the screenlines are within 0 percent of the observed volumes. The majority of screenlines, 69 percent, are within 15 percent of the observed volumes (11 screenlines out of 16).

For the daily period shown in Table 6.5, 1 screenline did not meet the FHWA validation criteria, however, overall model volumes at the screenlines are within 5 percent of the observed volumes. The majority of screenlines, 81 percent, are within 15 percent of the observed volumes (13 screenlines out of 16).

## Table 6.1 AM Peak Hour Screenline Validation – 2010 Base

| SCREENLINE | Location | AM Peak Hour | | | | |
|---|---|---|---|---|---|---|
| | | 2010 Modeled | 2010 Observed | Percent Error | Criteria | Meets Criteria |
| 1 | Cordon Line | 114,987 | 114,646 | 0% | 25% | YES |
| 2 | Albany-Berkeley | 18,625 | 18,742 | -1% | 55% | YES |
| 3 | Berkeley-Emeryville | 15,804 | 16,852 | -6% | 55% | YES |
| 4 | Berkeley-Oakland | 11,565 | 5,773 | 100% | 55% | NO |
| 5 | Emeryville-Oakland | 15,652 | 16,535 | -5% | 55% | YES |
| 6 | Oakland-Piedmont | 3,570 | 3,391 | 5% | 60% | YES |
| 7 | Alameda-Oakland | 15,320 | 13,824 | 11% | 55% | YES |
| 8 | Oakland-San Leandro | 13,890 | 13,753 | 1% | 55% | YES |
| 9 | Oakland-San Leandro | 27,124 | 26,926 | 1% | 45% | YES |
| 10 | Hayward - Union City | 27,693 | 19,764 | 40% | 55% | YES |
| 11 | Castro Valley/Ashland/Cherryland | 30,901 | 34,897 | -11% | 55% | YES |
| 12 | Union City – Fremont | 24,194 | 20,434 | 18% | 55% | YES |
| 13 | Fremont – Newark | 23,790 | 26,297 | -10% | 55% | YES |
| 14 | Around Sunol | 14,518 | 14,166 | 2% | 55% | YES |
| 15 | Dublin – Pleasanton | 30,677 | 35,504 | -14% | 45% | YES |
| 16 | Pleasanton – Livermore | 17,568 | 16,082 | 9% | 55% | YES |
| All | All | 405,878 | 397,586 | 2% | 5% | YES |

## Table 6.2 PM Peak Hour Screenline Validation – 2010 Base

| SCREENLINE | Location | PM Peak Hour | | | | |
|---|---|---|---|---|---|---|
| | | 2010 Modeled | 2010 Observed | Percent Error | Criteria | Meets Criteria |
| 1 | Cordon Line | 126,044 | 118,757 | 6% | 25% | YES |
| 2 | Albany-Berkeley | 20,636 | 20,766 | -1% | 55% | YES |
| 3 | Berkeley-Emeryville | 17,238 | 15,403 | 12% | 55% | YES |
| 4 | Berkeley-Oakland | 12,571 | 10,783 | 17% | 55% | YES |
| 5 | Emeryville-Oakland | 17,955 | 16,175 | 11% | 55% | YES |
| 6 | Oakland-Piedmont | 3,844 | 4,712 | -18% | 60% | YES |
| 7 | Alameda-Oakland | 16,673 | 14,896 | 12% | 55% | YES |
| 8 | Oakland-San Leandro | 16,571 | 16,160 | 3% | 55% | YES |
| 9 | Oakland-San Leandro | 29,151 | 30,917 | -6% | 45% | YES |
| 10 | Hayward - Union City | 17,983 | 21,312 | -16% | 55% | YES |
| 11 | Castro Valley/Ashland/Cherryland | 33,330 | 39,069 | -15% | 55% | YES |
| 12 | Union City - Fremont | 24,745 | 21,857 | 13% | 55% | YES |
| 13 | Fremont - Newark | 24,799 | 30,713 | -19% | 55% | YES |
| 14 | Around Sunol | 14,491 | 13,785 | 5% | 55% | YES |
| 15 | Dublin - Pleasanton | 34,460 | 44,767 | -23% | 45% | YES |
| 16 | Pleasanton - Livermore | 18,484 | 17,800 | 4% | 55% | YES |
| All | All | 428,975 | 437,872 | -2% | 5% | YES |

## Table 6.3 AM Peak Period Screenline Validation – 2010 Base

| SCREENLINE | Location | AM Peak 4 Hour Period | | | | |
|---|---|---|---|---|---|---|
| | | 2010 Modeled | 2010 Observed | Percent Error | Criteria | Meets Criteria |
| 1 | Cordon Line | 420,374 | 420,806 | 0% | 20% | YES |
| 2 | Albany-Berkeley | 70,088 | 69,444 | 1% | 30% | YES |
| 3 | Berkeley-Emeryville | 60,550 | 62,390 | -3% | 30% | YES |
| 4 | Berkeley-Oakland | 38,202 | 20,920 | 83% | 35% | NO |
| 5 | Emeryville-Oakland | 60,102 | 59,902 | 0% | 30% | YES |
| 6 | Oakland-Piedmont | 11,633 | 10,387 | 12% | 45% | YES |
| 7 | Alameda-Oakland | 49,160 | 43,619 | 13% | 30% | YES |
| 8 | Oakland-San Leandro | 44,462 | 41,410 | 7% | 30% | YES |
| 9 | Oakland-San Leandro | 98,129 | 97,357 | 1% | 25% | YES |
| 10 | Hayward - Union City | 93,931 | 69,144 | 36% | 30% | NO |
| 11 | Castro Valley/Ashland/Cherryland | 112,874 | 121,712 | -7% | 35% | YES |
| 12 | Union City - Fremont | 79,475 | 70,412 | 13% | 30% | YES |
| 13 | Fremont - Newark | 80,090 | 91,916 | -13% | 30% | YES |
| 14 | Around Sunol | 54,959 | 49,788 | 10% | 35% | YES |
| 15 | Dublin - Pleasanton | 107,668 | 118,072 | -9% | 25% | YES |
| 16 | Pleasanton - Livermore | 67,452 | 59,522 | 13% | 30% | YES |
| All | All | 1,449,149 | 1,406,801 | 3% | 5% | YES |

## Table 6.4 PM Peak Period Screenline Validation – 2010 Base

| SCREENLINE | Location | PM Peak 4 Hour Period | | | | |
|---|---|---|---|---|---|---|
| | | 2010 Modeled | 2010 Observed | Percent Error | Criteria | Meets Criteria |
| 1 | Cordon Line | 488,170 | 451,635 | 8% | 20% | YES |
| 2 | Albany-Berkeley | 82,693 | 81,088 | 2% | 30% | YES |
| 3 | Berkeley-Emeryville | 68,054 | 61,368 | 11% | 30% | YES |
| 4 | Berkeley-Oakland | 47,929 | 41,354 | 16% | 35% | YES |
| 5 | Emeryville-Oakland | 69,218 | 64,470 | 7% | 30% | YES |
| 6 | Oakland-Piedmont | 13,937 | 18,000 | -23% | 45% | YES |
| 7 | Alameda-Oakland | 59,221 | 58,176 | 2% | 30% | YES |
| 8 | Oakland-San Leandro | 58,093 | 61,765 | -6% | 30% | YES |
| 9 | Oakland-San Leandro | 113,680 | 117,976 | -4% | 25% | YES |
| 10 | Hayward - Union City | 103,721 | 82,893 | 25% | 30% | YES |
| 11 | Castro Valley/Ashland/Cherryland | 132,150 | 147,391 | -10% | 35% | YES |
| 12 | Union City - Fremont | 89,968 | 85,142 | 6% | 30% | YES |
| 13 | Fremont - Newark | 91,016 | 120,941 | -25% | 30% | YES |
| 14 | Around Sunol | 59,152 | 52,767 | 12% | 35% | YES |
| 15 | Dublin – Pleasanton | 132,327 | 167,440 | -21% | 25% | YES |
| 16 | Pleasanton - Livermore | 77,010 | 68,767 | 12% | 30% | YES |
| All | All | 1,686,339 | 1,681,173 | 0% | 5% | YES |

**Table 6.5 Daily Screenline Validation – 2010 Base**

| SCREENLINE | Location | Daily Volume | | | | |
|---|---|---|---|---|---|---|
| | | 2010 Modeled | 2010 Observed | Percent Error | Criteria | Meets Criteria |
| 1 | Cordon Line | 1,735,309 | 1,675,611 | 4% | 20% | YES |
| 2 | Albany-Berkeley | 302,328 | 318,847 | -5% | 20% | YES |
| 3 | Berkeley-Emeryville | 264,421 | 272,342 | -3% | 20% | YES |
| 4 | Berkeley-Oakland | 150,460 | 139,981 | 7% | 25% | YES |
| 5 | Emeryville-Oakland | 263,219 | 268,502 | -2% | 20% | YES |
| 6 | Oakland-Piedmont | 46,080 | 50,478 | -9% | 30% | YES |
| 7 | Alameda-Oakland | 189,489 | 198,947 | -5% | 20% | YES |
| 8 | Oakland-San Leandro | 174,403 | 204,032 | -15% | 20% | YES |
| 9 | Oakland-San Leandro | 385,596 | 429,381 | -10% | 20% | YES |
| 10 | Hayward - Union City | 351,270 | 310,566 | 13% | 20% | YES |
| 11 | Castro Valley/Ashland/Cherryland | 433,632 | 516,643 | -16% | 20% | YES |
| 12 | Union City – Fremont | 289,911 | 304,237 | -5% | 20% | YES |
| 13 | Fremont – Newark | 301,784 | 444,083 | -32% | 20% | NO |
| 14 | Around Sunol | 205,452 | 182,312 | 13% | 25% | YES |
| 15 | Dublin – Pleasanton | 446,586 | 540,865 | -17% | 20% | YES |
| 16 | Pleasanton – Livermore | 257,302 | 258,493 | 0% | 20% | YES |
| All | All | 5,797,242 | 6,115,320 | -5% | 5% | YES |

## 6.3 Transit Validation

The results of the transit validation are summarized in Table 6.6. Unlike the vehicle validation, transit validation does not have a standard set of validation criteria that can be applied to measure the validity of the transit assignments. For this project, the transit validation criteria will be to be within 15 percent error of observed boardings at the operator level.

A comparison of the modeled transit boardings to the observed transit boardings is provided in Table 6.6. There is a wide variation on the performance of the model relative to observed boardings, but the overall trend is that the model performs well for larger operators and the precision decreases for the smaller operators. Overall, the model is within 1 percent of observed boardings for all operators within and adjacent to Alameda County. For all operators in Alameda County (not including BART) the modeled transit boardings are within 10 percent error of system boardings.

**Table 6.6 Daily Transit Boardings, Modeled versus Observed - 2010 Base**

| Operator | 2010 Model | 2010 Observed | Percent Difference |
|---|---|---|---|
| BART | 344,479 | 345,256 | -0.2% |
| AC Transit Local Bus | 178,080 | 167,105 | 6.6% |
| AC Transit Transbay Bus | 17,918 | 15,786 | 13.5% |
| LAVTA | 6,706 | 6,093 | 10.1% |
| Union City | 2,583 | 1,696 | 52.3% |
| Emery-go-Round | 9,890 | 4,790 | 106.5% |
| Dumbarton Express | 2,021 | 1,118 | 80.8% |
| ACE | 2,372 | 2,025 | 17.1% |
| Capitol Corridor | 1,668 | 1,666 | 0.1% |
| Caltrain | 45,491 | 37,779 | 20.4% |
| East Bay Ferry | 1,132 | 1,853 | -38.9% |
| Vallejo Ferry | 1,627 | 1,737 | -6.3% |
| MUNI Metro | 135,806 | 162,023 | -16.2% |
| MUNI Bus | 440,684 | 514,817 | -14.4% |
| SamTrans Local Bus | 61,831 | 40,823 | 51.5% |
| SamTrans Express Bus | 1,425 | 1,481 | -3.8% |
| VTA Light Rail | 29,300 | 31,739 | -7.7% |
| VTA Local Bus | 144,922 | 108,362 | 33.7% |
| CCCTA | 19,126 | 9,302 | 105.6% |
| Tri-Delta | 10,154 | 8,257 | 23.0% |
| WestCat | 4,579 | 3,652 | 25.4% |
| AirBART | 1,388 | 1,800 | -22.9% |
| All | 1,463,182 | 1,469,160 | -0.4% |
| | | | |
| Alameda County Operators | 223,758 | 203,932 | 9.7% |

Table 6.7 summarizes a comparison of the model estimated daily BART station ons and offs to the observed station count data. The results show that while the model is within the 15 percent validation error tolerance for all stations in Alameda County, there is significant variation between the stations in terms of validation performance. When adjacent stations are grouped, however, as shown in Table 6.8, the model performs much more reliably, as the majority of station groups meet the 15 percent error threshold. While very accurate at the system level, this indicates that for BART ridership, the current countywide models also perform accurately when examined at the corridor level of detail, however, added refinements (for example, refining access connections at each station with observed mode of access data) could improve the validation at the individual station level.

**Table 6.7 Daily BART Station Boardings, Modeled versus Observed – 2010 Base Validation**

| Station | 2010 Model | 2010 Observed | Percent Difference |
|---|---|---|---|
| Rockridge | 3,654 | 5,267 | -30.6% |
| MacArthur | 10,217 | 8,015 | 27.5% |
| 19th | 12,663 | 9,675 | 30.9% |
| 12th | 20,156 | 12,181 | 65.5% |
| West Oakland | 2,809 | 5,050 | -44.4% |
| Berkeley | 8,887 | 11,749 | -24.4% |
| N. Berkeley | 4,126 | 3,967 | 4.0% |
| Ashby | 3,746 | 4,129 | -9.3% |
| Fremont | 5,699 | 7,332 | -22.3% |
| Union City | 4,393 | 3,853 | 14.0% |
| S. Hayward | 2,417 | 2,966 | -18.5% |
| Hayward | 4,048 | 4,451 | -9.1% |
| Bayfair | 4,991 | 5,154 | -3.2% |
| San Leandro | 4,535 | 5,124 | -11.5% |
| Coliseum | 5,741 | 6,564 | -12.5% |
| Fruitvale | 10,361 | 7,180 | 44.3% |
| Lake Merritt | 5,463 | 5,618 | -2.8% |
| Castro Valley | 2,129 | 2,389 | -10.9% |
| Dublin/Pleasanton | 5,799 | 7,481 | -22.5% |
| West Dublin | 1,805 | 652 | 176.8% |
| All | 123,639 | 118,797 | 4.1% |

**Table 6.8 Daily BART Station Boardings by Group, Modeled versus Observed – 2010 Base Validation**

| Station Group | 2010 Model | 2010 Observed | Percent Difference |
|---|---|---|---|
| N. Berkeley, Berkeley, Ashby | 16,759 | 19,845 | -15.6% |
| 19th, 12th, Lake Merritt | 38,282 | 27,474 | 39.3% |
| Rockridge, MacArthur, West Oakland | 16,680 | 18,332 | -9.0% |
| Fruitvale, Coliseum , San Leandro, Bayfair | 25,628 | 24,022 | 6.7% |
| Hayward, S. Hayward, Union City, Fremont | 16,557 | 18,602 | -11.0% |
| Castro Valley, West Dublin, Dublin/Pleasanton | 9,733 | 10,522 | -7.5% |
| All | 123,639 | 118,797 | 4.1% |

## 6.4 Bicycle Validation

Table 6.9 summarizes the results of the validation of base year 2010 model bicycle volumes to observed daily bicycle counts. The results reported in Table 6.9 indicate that overall daily bicycle volumes are under estimated by the models by 29.8 %, however, at the Planning Area level, the results are much closer for Planning Areas 2 and 3, at 9 percent and 3 percent of observed bicycle counts. It should be noted that only 63 counts were available for comparison to the model estimated volumes and this cannot be considered a representative sample of observed bicycle volumes. In the future, additional count data should be used to verify the accuracy of the estimated bicycle volumes.

# Table 6.9 Daily Bicycle Validation Results – 2010 Base Validation

| Location No | North/South Street | East/West Street | City | Counts | Model | Percent Difference | Ratio |
|---|---|---|---|---|---|---|---|
| 1 | ATLANTIC AVENUE | WEBSTER STREET | ALAMEDA | 189 | 154 | -18.5% | 0.81 |
| 2 | BROADWAY | CALHOUN STREET | ALAMEDA | 210 | 102 | -51.4% | 0.49 |
| 3 | 5TH STREET | CENTRAL AVENUE | ALAMEDA | 531 | 108 | -79.7% | 0.20 |
| 4 | PARK STREET | OTIS DRIVE | ALAMEDA | 516 | 116 | -77.5% | 0.22 |
| 5 | MASONIC AVENUE | SOLANO AVENUE | ALBANY | 614 | 668 | 8.8% | 1.09 |
| 6 | JACKSON STREET | BUCHANAN STREET | ALBANY | 1055 | 499 | -52.7% | 0.47 |
| 7 | HILLEGASS AVENUE | ASHBY AVENUE | BERKELEY | 633 | 373 | -41.1% | 0.59 |
| 8 | MILVIA STREET | HEARST AVENUE | BERKELEY | 935 | 180 | -80.7% | 0.19 |
| 9 | TELEGRAPH AVENUE | ASHBY AVENUE | BERKELEY | 1116 | 2061 | 84.7% | 1.85 |
| 10 | COLLEGE AVENUE | DERBY STREET | BERKELEY | 2727 | 207 | -92.4% | 0.08 |
| 11 | SAN PABLO AVENUE | VIRGINIA STREET | BERKELEY | 935 | 572 | -38.8% | 0.61 |
| 12 | HESPERIAN BOULEVARD | LEWELLING BOULEVARD | ALAMEDA COUNTY | 269 | 632 | 134.9% | 2.35 |
| 13 | MISSION BOUELVARD (CA 185) | GROVE WAY | ALAMEDA COUNTY | 72 | 302 | 319.4% | 4.19 |
| 14 | CASTRO VALLEY BOULEVARD | REDWOOD ROAD | ALAMEDA COUNTY | 224 | 260 | 16.1% | 1.16 |
| 15 | SCARLETT DRIVE | DUBLIN BOULEVARD | DUBLIN | 113 | 94 | -16.8% | 0.83 |
| 16 | HACIENDA BOULEVARD | DUBLIN BOULEVARD | DUBLIN | 385 | 87 | -77.4% | 0.23 |
| 17 | CHRISTIE AVENUE | POWELL STREET | EMERYVILLE | 258 | 545 | 111.2% | 2.11 |
| 18 | SAN PABLO AVENUE | 40TH STREET | EMERYVILLE | 948 | 230 | -75.7% | 0.24 |
| 19 | WARM SPRINGS BOULEVARD | S. GRIMMER BOULEVARD | FREMONT | 393 | 249 | -36.6% | 0.63 |
| 20 | FREMONT BOULEVARD | MOWRY AVENUE | FREMONT | 189 | 425 | 124.9% | 2.25 |
| 21 | FREMONT BOULEVARD/WASHINGTON | UNION STREET | FREMONT | 286 | 276 | -3.5% | 0.97 |
| 22 | FREMONT BOULEVARD | PERALTA BOULEVARD | FREMONT | 120 | 188 | 56.7% | 1.57 |
| 23 | NICHOLS AVENUE | MISSION BOULEVARD | FREMONT | 84 | 188 | 123.8% | 2.24 |
| 24 | MOWRY AVENUE | CHERRY LANE | FREMONT | 967 | 162 | -83.2% | 0.17 |
| 25 | PASEO PADRE PARKWAY | MOWRY AVENUE | FREMONT | 283 | 477 | 68.6% | 1.69 |
| 26 | DECOTO ROAD | PASEO PADRE PARKWAY | FREMONT | 124 | 501 | 304.0% | 4.04 |
| 27 | AMADOR STREET | WEST WINTON AVENUE | HAYWARD | 255 | 184 | -27.8% | 0.72 |
| 28 | GRAND STREET | C STREET | HAYWARD | 65 | 334 | 413.8% | 5.14 |
| 29 | FOOTHILL BOULEVARD | D STREET | HAYWARD | 149 | 26 | -82.6% | 0.17 |
| 30 | MISSION BOULEVARD (CA 238) | JEFFERSON STREET | HAYWARD | 411 | 158 | -61.6% | 0.38 |
| 31 | SANTA CLARA STREET | OCIE WAY | HAYWARD | 178 | 430 | 141.6% | 2.42 |
| 32 | VASCO ROAD | EAST STREET | LIVERMORE | 327 | 57 | -82.6% | 0.17 |
| 33 | FIRST STREET | RAILROAD AVENUE | LIVERMORE | 167 | 74 | -55.7% | 0.44 |
| 34 | AIRPORT ACCESS ROAD | DOOLITTLE DRIVE (CA 61) | OAKLAND | 295 | 174 | -41.0% | 0.59 |
| 35 | MANDELA PARKWAY | 14TH STREET | OAKLAND | 221 | 381 | 72.4% | 1.72 |
| 36 | TELEGRAPH AVENUE | 27TH STREET | OAKLAND | 462 | 497 | 7.6% | 1.08 |
| 37 | SAN LEANDRO BOULEVARD | 66TH AVENUE | OAKLAND | 291 | 154 | -47.1% | 0.53 |
| 38 | BANCROFT AVENUE | AUSEON AVENUE | OAKLAND | 1320 | 969 | -26.6% | 0.73 |
| 39 | BROADWAY | 12TH STREET | OAKLAND | 971 | 267 | -72.5% | 0.27 |
| 40 | BROADWAY | 20TH STREET | OAKLAND | 200 | 88 | -56.0% | 0.44 |
| 41 | 13TH AVENUE | CHATHAM ROAD | OAKLAND | 131 | 604 | 361.1% | 4.61 |
| 42 | FRUITVALE AVENUE | FOOTHILL BOULEVARD | OAKLAND | 348 | 408 | 17.2% | 1.17 |
| 43 | FRUITVALE AVENUE | ALAMEDA AVENUE | OAKLAND | 548 | 517 | -5.7% | 0.94 |
| 44 | STATEN AVENUE | GRAND AVENUE | OAKLAND | 1065 | 1098 | 3.1% | 1.03 |
| 45 | LAKE PARK | GRAND AVENUE | OAKLAND | 728 | 608 | -16.5% | 0.84 |
| 46 | MACARTHUR BOULEVARD | 38TH AVENUE | OAKLAND | 171 | 483 | 182.5% | 2.82 |
| 47 | MOUNTAIN BOULEVARD | LA SALLE AVENUE | OAKLAND | 720 | 0 | -100.0% | 0.00 |
| 48 | TELEGRAPH AVENUE | 40TH STREET | OAKLAND | 313 | 1197 | 282.4% | 3.82 |
| 49 | 7TH STREET | WEBSTER STREET | OAKLAND | 2225 | 102 | -95.4% | 0.05 |
| 50 | GRAND AVENUE | OAKLAND AVENUE | PIEDMONT | 1687 | 363 | -78.5% | 0.22 |
| 51 | SANTA RITA ROAD | FRANCISCO STREET | PLEASANTON | 469 | 93 | -80.2% | 0.20 |
| 52 | MAIN STREET | BERNAL AVENUE | PLEASANTON | 241 | 26 | -89.2% | 0.11 |
| 53 | OWENS DRIVE | ANDREWS DRIVE | PLEASANTON | 58 | 175 | 201.7% | 3.02 |
| 54 | HOPYARD ROAD | STONERIDGE DRIVE | PLEASANTON | 102 | 161 | 57.8% | 1.58 |
| 55 | BANCROFT AVENUE | ESTUDILLO AVENUE | SAN LEANDRO | 178 | 616 | 246.1% | 3.46 |
| 56 | PIERCE AVENUE/DOUGLAS DRIVE | DAVIS STREET (CA 61) | SAN LEANDRO | 102 | 177 | 73.5% | 1.74 |
| 57 | EAST 14 STREET (CA 185) | HESPERIAN BOULEVARD | SAN LEANDRO | 425 | 430 | 1.2% | 1.01 |
| 58 | EAST 14 STREET (CA 185) | MAUD AVENUE | SAN LEANDRO | 262 | 81 | -69.1% | 0.31 |
| 59 | ARDENWOOD BOULEVARD (CA 84) | NEWARK BOULEVARD (EAST SID | NEWARK | 178 | 202 | 13.5% | 1.13 |
| 60 | WILLOW STREET | THORNTON AVENUE | NEWARK | 210 | 76 | -63.8% | 0.36 |
| 61 | DECOTO ROAD | 7TH STREET | UNION CITY | 829 | 340 | -59.0% | 0.41 |
| 62 | DYER STREET | ALVARADO-NILES ROAD | UNION CITY | 1000 | 517 | -48.3% | 0.52 |
| 63 | DECOTO ROAD | ALVARADO-NILES ROAD | UNION CITY | 138 | 486 | 252.2% | 3.52 |
| **TOTAL** | | | | **31616** | **22209** | **-29.8%** | **0.70** |
| **Planning Area Summary** | | | | | | | |
| 1 | Planning Area 1 | | | 22363 | 13725 | -38.6% | 0.61 |
| 2 | Planning Area 2 | | | 4557 | 4973 | 9.1% | 1.09 |
| 3 | Planning Area 3 | | | 2834 | 2744 | -3.2% | 0.97 |
| 4 | Planning Area 4 | | | 1862 | 767 | -58.8% | 0.41 |

# 7.0 Model Forecasts and Summary of Performance

With the completion of the 2000 calibration and 2010 validation, the Alameda CTC models were applied to develop travel demand forecasts for the horizon years 2020 and 2040. The forecasts were developed based on the following input assumptions:

1. Socioeconomic data for 2020 and 2040 reflected ABAG Projections 2013 (Sustainable Community Strategies) data series reviewed and modified based on local jurisdiction review.
2. Year 2020 and 2040 highway, transit and bicycle network assumptions reflected projects based on the adopted Plan Bay Area Regional Transportation Plan, with the following specifications:
   a. Year 2040 roadway and transit projects were based on the adopted project list from Plan Bay Area.
   b. Year 2040 bicycle projects were based on physical descriptions of bicycle improvements from locally adopted bicycle plans and from projects defined in the Alameda Countywide Bicycle Plan.
   c. Year 2020 roadway and transit projects were based on estimated project completion timelines provided by MTC and then subsequent review by local jurisdictions for completeness.
   d. Year 2020 bicycle infrastructure improvements were based on a assumption that projects assumed for 2040 would be in place by 2020 if the projects were located within 0.5 miles of major transit stops/stations.
3. Pricing assumptions for parking, tolls and auto operating costs were consistent with pricing assumptions used by MTC when modeling the Plan Bay Area horizons.

## 7.1 Forecast Results

The following results generated from the model forecasts are produced and summarized from the different components of the Countywide models. This includes the auto ownership and workers per household, trip generation, trip distribution, mode choice, highway, transit and bicycle assignments. All model results are presented for the base year 2010 and forecast years 2020 and 2040.

### 7.1.1 Auto Ownership/Workers Per Household

The results of the application of the workers and vehicle ownership models are presented in Table 7.1. The results summarize the number of households with 0, 1, and 2 or more workers and vehicles. The overall trend from the base year 2010 to 2040 indicates that the number of workers per household is decreasing over time across the region and within each county. The number of autos per household also decreases over time for the region and at the county level.

**Table 7.1 Proportion of Workers Per Household and Vehicles per Household by County**

| | Workers/Household | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 Workers | | | 1 Worker | | | 2+ Workers | | |
| **County** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** |
| San Francisco | 33.4% | 39.0% | 37.1% | 32.9% | 33.0% | 31.7% | 33.7% | 33.0% | 31.2% |
| San Mateo | 25.7% | 25.7% | 29.7% | 37.0% | 37.0% | 36.6% | 37.2% | 37.3% | 33.6% |
| Santa Clara | 25.6% | 25.7% | 29.0% | 35.6% | 35.6% | 34.7% | 38.9% | 38.8% | 36.3% |
| Alameda | 27.3% | 27.3% | 29.0% | 37.7% | 37.7% | 36.9% | 35.0% | 35.0% | 34.1% |
| Contra Costa | 31.5% | 31.5% | 32.9% | 35.4% | 35.5% | 35.1% | 33.1% | 33.1% | 32.0% |
| Solano | 34.0% | 33.9% | 37.4% | 37.2% | 37.2% | 36.3% | 28.8% | 28.8% | 26.3% |
| Napa | 35.5% | 35.6% | 37.6% | 37.5% | 37.5% | 36.9% | 27.0% | 26.9% | 25.5% |
| Sonoma | 39.5% | 39.5% | 43.3% | 36.8% | 36.8% | 35.4% | 23.7% | 23.6% | 21.3% |
| Marin | 41.0% | 30.3% | 49.8% | 36.4% | 39.0% | 33.2% | 22.6% | 30.7% | 17.0% |
| **All** | **30.0%** | **30.1%** | **32.9%** | **36.0%** | **36.0%** | **35.1%** | **34.0%** | **33.8%** | **31.9%** |

| | Vehicles/Household | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 Autos | | | 1 Auto | | | 2+ Autos | | |
| **County** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** |
| San Francisco | 27.5% | 31.4% | 36.7% | 43.0% | 42.1% | 39.2% | 29.5% | 26.5% | 24.1% |
| San Mateo | 6.4% | 9.1% | 11.6% | 29.4% | 32.8% | 34.6% | 64.2% | 58.1% | 53.8% |
| Santa Clara | 8.1% | 9.8% | 13.5% | 32.6% | 32.9% | 35.0% | 59.3% | 57.3% | 51.4% |
| Alameda | 12.2% | 13.6% | 16.9% | 36.3% | 37.0% | 37.0% | 51.6% | 49.4% | 46.1% |
| Contra Costa | 5.6% | 7.3% | 8.4% | 29.6% | 30.7% | 31.5% | 64.8% | 62.0% | 60.0% |
| Solano | 4.9% | 6.9% | 7.9% | 28.9% | 32.1% | 33.0% | 66.1% | 61.1% | 59.2% |
| Napa | 4.9% | 6.1% | 6.6% | 31.1% | 33.0% | 33.4% | 64.0% | 60.9% | 60.0% |
| Sonoma | 5.1% | 6.6% | 7.9% | 32.6% | 35.3% | 36.3% | 62.2% | 58.1% | 55.8% |
| Marin | 4.8% | 5.5% | 6.2% | 32.4% | 34.9% | 36.2% | 62.8% | 59.6% | 57.6% |
| **All** | **10.4%** | **12.5%** | **15.4%** | **33.8%** | **34.9%** | **35.5%** | **55.8%** | **52.7%** | **49.1%** |

### 7.1.2 Trip Generation

Trip generation models estimate the trip productions and attractions by each individual trip purpose. The results of the trip generation models, trips by individual trip purpose, are summarized in Table 7.2. The results of the trip generation output indicate that for the most part overall trips by trip purpose are increasing over time, which is related to the continued increase in households, population and jobs for the region. School trips show a small decrease in 2020, and that is related to the change in population by specific age category, and the proportion of population by age of school children showing a slight decrease in the short term, but then increases again by 2040.

**Table 7.2 Regional Person Trips, Internal and External Trip Purposes**

| Trip Purpose - Internal Person Trips | 2010 | 2020 | 2040 |
|---|---|---|---|
| Home Based Work | 4,746,928 | 5,576,182 | 6,313,160 |
| Home Based Shopping/Other | 5,600,290 | 6,056,569 | 7,097,893 |
| Home Based Social-Recreational | 3,693,137 | 3,851,398 | 4,430,782 |
| Non-home-based | 4,314,931 | 4,990,144 | 5,701,549 |
| Home-based Grade School | 1,201,374 | 1,206,145 | 1,348,330 |
| Home-based High School | 515,684 | 515,030 | 569,115 |
| Home-based College | 522,544 | 524,849 | 530,689 |
| Air Passenger Enplanements | 99,914 | 209,939 | 333,704 |
| All Internal Person Trips | 20,694,802 | 22,930,256 | 26,325,222 |
| | | | |
| **Truck Vehicle Trips** | **2010** | **2020** | **2040** |
| Truck Vehicles - Very Small Internal | 3,069,511 | 3,571,585 | 4,087,985 |
| Trucks - Light Duty Internal | 170,884 | 202,566 | 230,886 |
| Trucks - Medium Duty Internal | 136,814 | 162,859 | 186,734 |
| Truck - Heavy Duty Combo Internal | 49,339 | 59,918 | 71,109 |
| Trucks - Light Duty External-Internal | 12,581 | 14,401 | 17,723 |
| Trucks - Medium Duty External-Internal | 7,202 | 8,447 | 10,004 |
| Truck - Heavy Duty Combo External-Internal | 40,578 | 48,368 | 60,593 |
| All Truck Vehicle Trips | 3,499,196 | 4,077,705 | 4,668,810 |

### 7.1.3 Trip Distribution

Trip distribution outputs generated by the models of significance include average trip lengths by each trip purpose and summaries of the zone to zone trips in an easily understood format Table 7.3 summarizes the average trip length of regional trips by trip purpose. The trends exhibited in Table 7.3 indicate that there is variability in the average trip length changes over time, with home-based work trips average trip lengths shortening over time, and both increases and decreases in average trip lengths for the non-work trip purpose. Of particular significance is that home-based work trip lengths show the largest decreases over time, which would indicate that workers and jobs are located more efficiently from 2010 to 2040.

Table 7.4 summarizes home-based work trips for County-to-County level interchanges for regional internal trips. For Alameda County, all trip interchanges increase from 2010 to 2040, however, the rate of growth differs significantly for each interchange. Alameda County retains most the total work trip attractions made by workers residing in Alameda County, with San Francisco and Santa Clara County receiving the most workers from Alameda County, respectively for the base and future years. Alameda County imports most workers from outside Alameda County from Contra Costa, San Joaquin and Santa Clara Counties respectively in that order from the base year to 2040.

## Table 7.3 Average Trip Length by Trip Purpose

| *Home-based Work* | 2010 Model | 2020 Model | 2040 Model |
|---|---|---|---|
| Total Trips | 4,746,928 | 5,576,182 | 6,313,160 |
| Average Trip Length, Miles | 13.05 | 12.9 | 12.73 |
| Average Trip Length, Minutes | 24.66 | 24.49 | 24.26 |
| | | | |
| ***Home-based Shopping/Other*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 5,600,290 | 6,056,569 | 7,097,893 |
| Average Trip Length, Miles | 5.31 | 5.27 | 5.22 |
| Average Trip Length, Minutes | 14.44 | 14.43 | 14.38 |
| | | | |
| ***Home-based Social-Recreational*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 3,693,137 | 3,851,398 | 4,430,782 |
| Average Trip Length, Miles | 6.95 | 7.06 | 7 |
| Average Trip Length, Minutes | 16.73 | 16.86 | 16.79 |
| | | | |
| ***Non-home-based*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 4,314,931 | 4,990,144 | 5,701,549 |
| Average Trip Length, Miles | 6.52 | 6.46 | 6.42 |
| Average Trip Length, Minutes | 16.58 | 16.53 | 16.46 |
| | | | |
| ***Home-based Grade School*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 1,201,374 | 1,206,145 | 1,348,330 |
| Average Trip Length, Miles | 2.94 | 2.92 | 2.88 |
| Average Trip Length, Minutes | 10.9 | 10.85 | 11.16 |
| | | | |
| ***Home-based High School*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 515,684 | 515,030 | 569,115 |
| Average Trip Length, Miles | 5.5 | 5.28 | 6.77 |
| Average Trip Length, Minutes | 14.71 | 14.54 | 16.24 |
| | | | |
| ***Home-based College School*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 522,544 | 524,849 | 530,689 |
| Average Trip Length, Miles | 9.01 | 8.73 | 10.16 |
| Average Trip Length, Minutes | 20.48 | 20.18 | 21.81 |
| | | | |
| ***All Trip Purposes*** | **2010 Model** | **2020 Model** | **2040 Model** |
| Total Trips | 20,594,888 | 22,720,317 | 25,991,518 |
| Average Trip Length, Miles | 7.60 | 7.66 | 7.62 |
| Average Trip Length, Minutes | 17.61 | 17.72 | 17.67 |

## Table 7.4 Home-based Work County to County Trips – Production County to Attraction County

| 2010 | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | San Joaquin | All |
|---|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 480,043 | 59,148 | 21,087 | 16,196 | 4,683 | 466 | 407 | 1,392 | 7,847 | 58 | 591,326 |
| San Mateo | 110,220 | 296,344 | 77,609 | 11,866 | 2,202 | 361 | 272 | 665 | 2,940 | 107 | 502,586 |
| Santa Clara | 21,106 | 68,295 | 1,065,677 | 36,396 | 5,577 | 1,028 | 489 | 753 | 2,177 | 476 | 1,201,975 |
| Alameda | 114,235 | 48,371 | 93,408 | 678,267 | 44,413 | 3,940 | 1,182 | 3,440 | 6,769 | 1,649 | 995,676 |
| Contra Costa | 95,831 | 15,381 | 16,299 | 120,539 | 377,371 | 13,191 | 4,293 | 2,904 | 11,717 | 4,684 | 662,211 |
| Solano | 20,168 | 5,869 | 4,580 | 16,671 | 28,889 | 131,862 | 16,730 | 3,101 | 5,386 | 898 | 234,152 |
| Napa | 1,994 | 842 | 2,951 | 1,153 | 2,074 | 4,197 | 62,546 | 3,631 | 1,260 | 153 | 80,801 |
| Sonoma | 14,538 | 3,237 | 14,312 | 2,742 | 2,148 | 1,333 | 8,229 | 253,187 | 22,827 | 581 | 323,133 |
| Marin | 45,270 | 5,218 | 1,510 | 5,286 | 4,326 | 730 | 782 | 4,791 | 95,201 | 153 | 163,267 |
| San Joaquin | 3,633 | 2,971 | 12,654 | 40,917 | 9,019 | 3,478 | 515 | 371 | 429 | 269,903 | 343,890 |
| All | 907,039 | 505,676 | 1,310,087 | 930,033 | 480,701 | 160,585 | 95,445 | 274,235 | 156,554 | 278,662 | 5,099,017 |
| **2020** | **San Francisco** | **San Mateo** | **Santa Clara** | **Alameda** | **Contra Costa** | **Solano** | **Napa** | **Sonoma** | **Marin** | **San Joaquin** | **All** |
| San Francisco | 565,044 | 71,652 | 22,716 | 20,330 | 5,552 | 457.59 | 381.16 | 1,246 | 8,826 | 85.41 | 696,290 |
| San Mateo | 127,300 | 345,831 | 78,380 | 14,142 | 2,388 | 348.57 | 254.14 | 611.71 | 3,077 | 124.17 | 572,456 |
| Santa Clara | 21,412 | 81,199 | 1,288,859 | 42,712 | 4,935 | 1,094 | 722.25 | 1,128 | 1,385 | 832.95 | 1,444,279 |
| Alameda | 138,057 | 56,509 | 97,071 | 813,372 | 50,727 | 3,648 | 1,033 | 3,290 | 7,288 | 2,254 | 1,173,250 |
| Contra Costa | 117,380 | 19,036 | 17,859 | 151,074 | 439,427 | 13,463 | 3,979 | 2,362 | 12,758 | 6,926 | 784,264 |
| Solano | 25,579 | 7,144 | 4,583 | 21,534 | 35,342 | 147,868 | 19,566 | 3,788 | 6,806 | 1,539 | 273,750 |
| Napa | 2,599 | 1,105 | 3,065 | 1,544 | 2,580 | 4,906 | 70,840 | 4,301 | 1,531 | 241.72 | 92,713 |
| Sonoma | 17,572 | 3,942 | 14,939 | 3,478 | 2,563 | 1,489 | 8,980 | 293,639 | 25,980 | 833.25 | 373,414 |
| Marin | 51,003 | 5,948 | 1,450 | 6,209 | 4,802 | 781.89 | 784.95 | 5,055 | 101,969 | 196.52 | 178,201 |
| San Joaquin | 4,266 | 3,304 | 12,020 | 46,631 | 12,725 | 4,103 | 508.19 | 365.36 | 442.83 | 310,369 | 394,734 |
| All | 1,070,214 | 595,670 | 1,540,942 | 1,121,028 | 561,039 | 178,159 | 107,049 | 315,787 | 170,064 | 323,402 | 5,983,353 |
| **2040** | **San Francisco** | **San Mateo** | **Santa Clara** | **Alameda** | **Contra Costa** | **Solano** | **Napa** | **Sonoma** | **Marin** | **San Joaquin** | **All** |
| San Francisco | 647,976 | 76,179 | 22,117 | 25,710 | 6,926 | 596 | 474 | 1,705 | 10,367 | 113 | 792,163 |
| San Mateo | 148,874 | 374,749 | 81,606 | 17,515 | 2,954 | 465 | 307 | 821 | 3,799 | 159 | 631,249 |
| Santa Clara | 30,068 | 98,086 | 1,487,350 | 62,217 | 7,452 | 1,652 | 951 | 1,344 | 2,127 | 1,222 | 1,692,470 |
| Alameda | 152,621 | 56,782 | 94,949 | 937,115 | 58,409 | 4,638 | 1,318 | 4,647 | 9,296 | 3,068 | 1,322,844 |
| Contra Costa | 131,464 | 19,082 | 16,759 | 175,501 | 507,819 | 16,571 | 4,945 | 3,268 | 15,966 | 9,259 | 900,635 |
| Solano | 26,576 | 6,603 | 4,159 | 23,479 | 37,358 | 166,576 | 22,295 | 4,735 | 7,687 | 2,258 | 301,726 |
| Napa | 2,546 | 1,006 | 2,806 | 1,602 | 2,648 | 5,408 | 75,779 | 4,843 | 1,588 | 300 | 98,527 |
| Sonoma | 17,495 | 3,686 | 15,066 | 3,710 | 2,729 | 1,619 | 9,667 | 325,804 | 26,733 | 1,038 | 407,546 |
| Marin | 51,214 | 5,565 | 1,291 | 6,610 | 5,194 | 850 | 830 | 5,485 | 105,618 | 231 | 182,888 |
| San Joaquin | 5,415 | 3,613 | 12,022 | 55,944 | 14,713 | 4,390 | 567 | 415 | 522 | 396,398 | 493,998 |
| All | 1,214,249 | 645,350 | 1,738,125 | 1,309,403 | 646,203 | 202,765 | 117,133 | 353,066 | 183,705 | 414,046 | 6,824,045 |

### 7.1.4 Mode Choice

Mode choice estimates the trips by each mode for each trip purpose. The results of the mode choice models are presented in Table 7.5 for regional trips by mode for the base and forecasts years. The results indicate that from the base year 2010 to 2040, trips made by auto comprise a decreasing share of total trips for all trip purposes, with a corresponding increase in transit trips and non-motorized walk and bike trips. For the auto modes, drive-alone mode shares decrease the most, with shared ride auto trips increasing or slightly decreasing over the base year 2010.

## Table 7.5 Regional Trips by Mode

| Mode | Home-based Work | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Drive-Alone | 3,309,161 | 3,733,762 | 4,025,312 | 69.7% | 67.0% | 63.8% |
| Shared Ride 2 Person | 504,745 | 596,168 | 684,561 | 10.6% | 10.7% | 10.8% |
| Shared Ride 3+ Person | 171,459 | 205,629 | 243,536 | 3.6% | 3.7% | 3.9% |
| Transit Walk-access | 341,792 | 479,601 | 633,921 | 7.2% | 8.6% | 10.0% |
| Transit Drive Access | 162,848 | 223,947 | 291,886 | 3.4% | 4.0% | 4.6% |
| Bike | 55,489 | 79,065 | 108,558 | 1.2% | 1.4% | 1.7% |
| Walk | 201,379 | 257,975 | 325,370 | 4.2% | 4.6% | 5.2% |
| All | 4,746,873 | 5,576,147 | 6,313,144 | 100.0% | 100.0% | 100.0% |

| Mode | Home-based Shopping/Other | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Drive-Alone | 2,185,627 | 2,239,183 | 2,500,417 | 39.0% | 37.0% | 35.2% |
| Shared Ride 2 Person | 1,516,103 | 1,630,554 | 1,859,337 | 27.1% | 26.9% | 26.2% |
| Shared Ride 3+ Person | 1,025,458 | 1,160,631 | 1,382,725 | 18.3% | 19.2% | 19.5% |
| Transit Walk-access | 138,021 | 160,261 | 241,644 | 2.5% | 2.6% | 3.4% |
| Transit Drive Access | 12,217 | 17,186 | 28,077 | 0.2% | 0.3% | 0.4% |
| Bike | 64,902 | 737,75 | 90,251 | 1.2% | 1.2% | 1.3% |
| Walk | 657,955 | 773,997 | 994,434 | 11.7% | 12.8% | 14.0% |
| All | 5,600,283 | 6,055,587 | 7,096,885 | 100.0% | 100.0% | 100.0% |

| Mode | Home-based Social-Recreational | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Drive-Alone | 1,036,727 | 1,091,342 | 1,214,017 | 28.1% | 28.3% | 27.4% |
| Shared Ride 2 Person | 954,357 | 908,156 | 990,966 | 25.8% | 23.6% | 22.4% |
| Shared Ride 3+ Person | 1,175,293 | 1,255,118 | 1,438,155 | 31.8% | 32.6% | 32.5% |
| Transit Walk-access | 100,818 | 111,303 | 163,967 | 2.7% | 2.9% | 3.7% |
| Transit Drive Access | 13,394 | 17,712 | 27,836 | 0.4% | 0.5% | 0.6% |
| Bike | 58,877 | 80,782 | 104,692 | 1.6% | 2.1% | 2.4% |
| Walk | 353,661 | 385,988 | 490,175 | 9.6% | 10.0% | 11.1% |
| All | 3,693,127 | 3,850,401 | 4,429,808 | 100.0% | 100.0% | 100.0% |

| Mode | Non-home-based | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Vehicle Driver | 2,526,896 | 2,892,124 | 3,205,011 | 58.6% | 58.0% | 56.2% |
| Vehicle Passenger | 948,168 | 1,097,249 | 1,217,658 | 22.0% | 22.0% | 21.4% |
| Transit | 196,234 | 226,432 | 309,113 | 4.5% | 4.5% | 5.4% |
| Bike | 41,281 | 49,668 | 62,849 | 1.0% | 1.0% | 1.1% |
| Walk | 602,340 | 724,454 | 906,678 | 14.0% | 14.5% | 15.9% |
| All | 4,314,919 | 4,989,927 | 5,701,309 | 100.0% | 100.0% | 100.0% |

## Table 7.5, continued Regional Trips by Mode

| Mode | Home-based Grade/High School | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Vehicle Driver | 74,712 | 70,681 | 68,723 | 4.4% | 4.1% | 3.6% |
| Vehicle Passenger | 1,156,064 | 1,075,820 | 1,061,261 | 67.3% | 62.5% | 55.3% |
| Transit | 113,000 | 133,971 | 223,906 | 6.6% | 7.8% | 11.7% |
| Bike | 119,814 | 131,553 | 149,500 | 7.0% | 7.6% | 7.8% |
| Walk | 253,471 | 309,154 | 414,057 | 14.8% | 18.0% | 21.6% |
| All | 1,717,061 | 1,721,179 | 1,917,447 | 100.0% | 100.0% | 100.0% |

| Mode | Home-based College | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Vehicle Driver | 335,639 | 326,953 | 298,629 | 64.2% | 62.3% | 56.3% |
| Vehicle Passenger | 49,699 | 50,287 | 51,357 | 9.5% | 9.6% | 9.7% |
| Transit | 71,560 | 76,777 | 114,028 | 13.7% | 14.6% | 21.5% |
| Bike | 9,493 | 10,337 | 7,628 | 1.8% | 2.0% | 1.4% |
| Walk | 56,153 | 60,496 | 59,045 | 10.7% | 11.5% | 11.1% |
| All | 522,544 | 524,850 | 530,687 | 100.0% | 100.0% | 100.0% |

| Mode | All Trips | | | | | |
|---|---|---|---|---|---|---|
| | Trips | | | Shares | | |
| | 2010 | 2020 | 2040 | 2010 | 2020 | 2040 |
| Auto | 16,970,108 | 18,333,657 | 20,241,665 | 82.4% | 80.7% | 77.9% |
| Transit | 1,149,884 | 1,447,190 | 2,034,378 | 5.6% | 6.4% | 7.8% |
| Bike | 349,856 | 425,180 | 523,478 | 1.7% | 1.9% | 2.0% |
| Walk | 2,124,959 | 2,512,064 | 3,189,759 | 10.3% | 11.1% | 12.3% |
| All | 20,594,807 | 22,718,091 | 25,989,280 | 100.0% | 100.0% | 100.0% |

### 7.1.5 Vehicle Volume Screenline Summary

The output generated by the traffic assignments is summarized at the screenline level of detail. These screenlines are identical to the ones used for model validation. Tables 7.6 through 7.10 summarize roadway volumes across the 16 County screenlines for daily, AM peak hour, PM peak hour, AM peak 4-hour period and PM peak 4-hour period, respectively. In general, traffic volumes at all screenlines show increases in volumes from the base year 2010 through the forecast years of 2020 and 2040.

For all time periods, Screenline 8 (Oakland-San Leandro along International Boulevard) shows significant growth from 2010 to 2040. This indicates increases in vehicle volume demand will be highest in the northeast-southwest direction along International Boulevard from Lake Merritt south to Davis Street (SR-61). The second highest increases in vehicle demand occur at Screenline 4 (Berkeley-Oakland border) and at Screenline 15 in the Tri-Valley. This indicates that vehicle growth will occur in both the suburban travel markets and the urban travel markets of Alameda County, indicative of the in-fill growth assumptions from ABAG for the Planned Development Areas (PDAs) located in Alameda County.

**Table 7.6 Daily Vehicle Volumes at Screenlines**

| SCREENLINE | Location | Daily Volume | | | | |
|---|---|---|---|---|---|---|
| | | 2010 | 2020 | Percent Change 2010 to 2020 | 2040 | Percent Change 2010 to 2040 |
| 1 | Cordon Line | 1,735,309 | 1,941,676 | 12% | 2,211,738 | 27% |
| 2 | Albany-Berkeley | 302,328 | 332,940 | 10% | 374,456 | 24% |
| 3 | Berkeley-Emeryville | 264,421 | 286,754 | 8% | 313,129 | 18% |
| 4 | Berkeley-Oakland | 150,460 | 174,491 | 16% | 210,124 | 40% |
| 5 | Emeryville-Oakland | 263,219 | 281,990 | 7% | 313,099 | 19% |
| 6 | Oakland-Piedmont | 46,080 | 49,393 | 7% | 49,347 | 7% |
| 7 | Alameda-Oakland | 189,489 | 219,271 | 16% | 253,262 | 34% |
| 8 | Oakland-San Leandro | 174,403 | 211,062 | 21% | 252,241 | 45% |
| 9 | Oakland-San Leandro | 385,596 | 447,882 | 16% | 518,482 | 34% |
| 10 | Hayward - Union City | 351,270 | 393,562 | 12% | 438,049 | 25% |
| 11 | Castro Valley/Ashland/Cherryland | 433,632 | 500,755 | 15% | 573,292 | 32% |
| 12 | Union City - Fremont | 289,911 | 303,421 | 5% | 336,270 | 16% |
| 13 | Fremont - Newark | 301,784 | 339,321 | 12% | 373,524 | 24% |
| 14 | Around Sunol | 205,452 | 224,860 | 9% | 272,121 | 32% |
| 15 | Dublin - Pleasanton | 446,586 | 521,264 | 17% | 588,500 | 32% |
| 16 | Pleasanton - Livermore | 257,302 | 275,826 | 7% | 305,471 | 19% |
| All | All | 5,797,242 | 6,504,468 | 12% | 7,383,105 | 27% |

## Table 7.7 AM Peak Hour Vehicle Volumes at Screenlines

| SCREENLINE | Location | AM Peak Hour | | | | |
|---|---|---|---|---|---|---|
| | | 2010 | 2020 | Percent Change 2010 to 2020 | 2040 | Percent Change 2010 to 2040 |
| 1 | Cordon Line | 114,987 | 130,028 | 13% | 151,343 | 32% |
| 2 | Albany-Berkeley | 18,625 | 21,311 | 14% | 24,810 | 33% |
| 3 | Berkeley-Emeryville | 15,804 | 17,992 | 14% | 19,839 | 26% |
| 4 | Berkeley-Oakland | 11,565 | 13,221 | 14% | 15,474 | 34% |
| 5 | Emeryville-Oakland | 15,652 | 17,911 | 14% | 20,177 | 29% |
| 6 | Oakland-Piedmont | 3,570 | 3,858 | 8% | 3,900 | 9% |
| 7 | Alameda-Oakland | 15,320 | 17,784 | 16% | 21,110 | 38% |
| 8 | Oakland-San Leandro | 13,890 | 17,364 | 25% | 20,299 | 46% |
| 9 | Oakland-San Leandro | 27,124 | 31,906 | 18% | 36,781 | 36% |
| 10 | Hayward - Union City | 27,693 | 30,753 | 11% | 34,471 | 24% |
| 11 | Castro Valley/Ashland/Cherryland | 30,901 | 36,200 | 17% | 40,185 | 30% |
| 12 | Union City - Fremont | 24,194 | 25,333 | 5% | 27,895 | 15% |
| 13 | Fremont - Newark | 23,790 | 27,065 | 14% | 29,330 | 23% |
| 14 | Around Sunol | 14,518 | 15,868 | 9% | 18,614 | 28% |
| 15 | Dublin - Pleasanton | 30,677 | 36,182 | 18% | 42,759 | 39% |
| 16 | Pleasanton - Livermore | 17,568 | 18,225 | 4% | 20,329 | 16% |
| All | All | 405,878 | 461,001 | 14% | 527,316 | 30% |

## Table 7.8 PM Peak Hour Vehicle Volumes at Screenlines

| SCREENLINE | Location | PM Peak Hour | | | | |
|---|---|---|---|---|---|---|
| | | 2010 | 2020 | Percent Change 2010 to 2020 | 2040 | Percent Change 2010 to 2040 |
| 1 | Cordon Line | 126,044 | 147,061 | 17% | 168,119 | 33% |
| 2 | Albany-Berkeley | 20,636 | 23,628 | 14% | 26,859 | 30% |
| 3 | Berkeley-Emeryville | 17,238 | 19,058 | 11% | 20,962 | 22% |
| 4 | Berkeley-Oakland | 12,571 | 15,428 | 23% | 18,500 | 47% |
| 5 | Emeryville-Oakland | 17,955 | 19,555 | 9% | 22,174 | 23% |
| 6 | Oakland-Piedmont | 3,844 | 4,470 | 16% | 4,693 | 22% |
| 7 | Alameda-Oakland | 16,673 | 21,277 | 28% | 23,675 | 42% |
| 8 | Oakland-San Leandro | 16,571 | 22,762 | 37% | 27,252 | 64% |
| 9 | Oakland-San Leandro | 29,151 | 34,769 | 19% | 40,171 | 38% |
| 10 | Hayward - Union City | 17,983 | 31,732 | 76% | 34,480 | 92% |
| 11 | Castro Valley/Ashland/Cherryland | 33,330 | 39,222 | 18% | 45,043 | 35% |
| 12 | Union City - Fremont | 24,745 | 26,565 | 7% | 29,471 | 19% |
| 13 | Fremont - Newark | 24,799 | 28,698 | 16% | 31,436 | 27% |
| 14 | Around Sunol | 14,491 | 16,756 | 16% | 20,356 | 40% |
| 15 | Dublin - Pleasanton | 34,460 | 44,350 | 29% | 51,147 | 48% |
| 16 | Pleasanton - Livermore | 18,484 | 20,386 | 10% | 22,602 | 22% |
| All | All | 428,975 | 515,717 | 20% | 586,940 | 37% |

## Table 7.9 AM Peak Period Vehicle Volumes at Screenlines

| SCREENLINE | Location | AM Peak 4 Hour Period | | | | |
|---|---|---|---|---|---|---|
| | | 2010 | 2020 | Percent Change 2010 to 2020 | 2040 | Percent Change 2010 to 2040 |
| 1 | Cordon Line | 420,374 | 472,643 | 12% | 542,068 | 29% |
| 2 | Albany-Berkeley | 70,088 | 79,490 | 13% | 90,785 | 30% |
| 3 | Berkeley-Emeryville | 60,550 | 67,723 | 12% | 74,389 | 23% |
| 4 | Berkeley-Oakland | 38,202 | 44,085 | 15% | 53,392 | 40% |
| 5 | Emeryville-Oakland | 60,102 | 65,168 | 8% | 73,237 | 22% |
| 6 | Oakland-Piedmont | 11,633 | 12,269 | 5% | 12,509 | 8% |
| 7 | Alameda-Oakland | 49,160 | 57,402 | 17% | 65,752 | 34% |
| 8 | Oakland-San Leandro | 44,462 | 54,887 | 23% | 66,117 | 49% |
| 9 | Oakland-San Leandro | 98,129 | 113,475 | 16% | 129,758 | 32% |
| 10 | Hayward - Union City | 93,931 | 105,525 | 12% | 117,581 | 25% |
| 11 | Castro Valley/Ashland/Cherryland | 112,874 | 132,757 | 18% | 146,718 | 30% |
| 12 | Union City - Fremont | 79,475 | 83,206 | 5% | 91,867 | 16% |
| 13 | Fremont - Newark | 80,090 | 90,702 | 13% | 98,801 | 23% |
| 14 | Around Sunol | 54,959 | 59,812 | 9% | 70,944 | 29% |
| 15 | Dublin - Pleasanton | 107,668 | 128,005 | 19% | 150,323 | 40% |
| 16 | Pleasanton - Livermore | 67,452 | 70,758 | 5% | 78,347 | 16% |
| All | All | 1,449,149 | 1,637,907 | 13% | 1,862,588 | 29% |

## Table 7.10 PM Peak Period Vehicle Volumes at Screenlines

| SCREENLINE | Location | PM Peak 4 Hour Period | | | | |
|---|---|---|---|---|---|---|
| | | 2010 | 2020 | Percent Change 2010 to 2020 | 2040 | Percent Change 2010 to 2040 |
| 1 | Cordon Line | 488,170 | 549,315 | 13% | 629,375 | 29% |
| 2 | Albany-Berkeley | 82,693 | 92,704 | 12% | 103,846 | 26% |
| 3 | Berkeley-Emeryville | 68,054 | 75,859 | 11% | 83,430 | 23% |
| 4 | Berkeley-Oakland | 47,929 | 55,899 | 17% | 68,106 | 42% |
| 5 | Emeryville-Oakland | 69,218 | 73,351 | 6% | 83,175 | 20% |
| 6 | Oakland-Piedmont | 13,937 | 14,734 | 6% | 15,040 | 8% |
| 7 | Alameda-Oakland | 59,221 | 69,025 | 17% | 80,966 | 37% |
| 8 | Oakland-San Leandro | 58,093 | 71,038 | 22% | 84,776 | 46% |
| 9 | Oakland-San Leandro | 113,680 | 132,781 | 17% | 153,450 | 35% |
| 10 | Hayward - Union City | 103,721 | 117,016 | 13% | 128,397 | 24% |
| 11 | Castro Valley/Ashland/Cherryland | 132,150 | 149,113 | 13% | 169,368 | 28% |
| 12 | Union City - Fremont | 89,968 | 93,876 | 4% | 103,543 | 15% |
| 13 | Fremont - Newark | 91,016 | 102,932 | 13% | 114,101 | 25% |
| 14 | Around Sunol | 59,152 | 60,691 | 3% | 82,389 | 39% |
| 15 | Dublin - Pleasanton | 132,327 | 154,209 | 17% | 177,210 | 34% |
| 16 | Pleasanton - Livermore | 77,010 | 82,672 | 7% | 91,517 | 19% |
| All | All | 1,686,339 | 1,895,215 | 12% | 2,168,689 | 29% |

### 7.1.6 Vehicle-Miles-Traveled (VMT), Vehicle-Hours-Traveled (VHT) and Average Speeds (MPH)

A more comprehensive set of model outputs that characterizes the level of congestion for the roadway networks are vehicle-miles-traveled (VMT), vehicle-hours-traveled (VHT) and the corresponding network speed in miles-per-hour. These metrics are summarized based on area, such as at the regional or county-level, and by facility types, such as by freeway, arterial or expressway. The VMT, VHT and average speeds generated speeds by the Countywide models are summarized in Tables 7.11 and 7.12 for the regional AM and PM peak hours and periods and Alameda County AM and PM peak hours and periods, respectively. The VMT, VHT and average speeds generated speeds by the Countywide models for daily traffic conditions are summarized in Table 7.13 and 7.14 for the region and Alameda County, respectively.

## Table 7.11 Regional Vehicle-Miles-Traveled, Vehicle-Hours-Traveled and Average Speed, AM and PM Peak Hour and Period

| **Regional** | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle-Miles Traveled | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period |
| Freeway | 6,367,228 | 6,920,690 | 24,402,452 | 27,317,774 | 7,073,842 | 7,730,787 | 26,927,789 | 30,078,169 | 11% | 12% | 10% | 10% | 7,862,013 | 8,629,882 | 30,201,262 | 33,882,338 | 11% | 12% | 12% | 13% |
| Expressway | 884,099 | 984,109 | 3,390,104 | 3,966,007 | 1,026,730 | 1,164,960 | 3,922,194 | 4,549,108 | 16% | 18% | 16% | 15% | 1,273,043 | 1,462,398 | 4,949,397 | 5,789,292 | 24% | 26% | 26% | 27% |
| Arterial/Local Streets | 5,756,478 | 6,605,462 | 23,453,613 | 23,453,613 | 6,535,676 | 7,741,348 | 26,237,246 | 31,249,384 | 14% | 17% | 12% | 33% | 8,063,846 | 9,616,015 | 32,967,481 | 39,182,446 | 23% | 24% | 26% | 25% |
| Ramps | 246,260 | 263,361 | 837,434 | 837,434 | 280,517 | 309,258 | 958,333 | 1,119,029 | 14% | 17% | 14% | 34% | 321,101 | 354,852 | 1,113,877 | 1,308,101 | 14% | 15% | 16% | 17% |
| All Facility Types | 13,254,065 | 14,773,622 | 52,083,603 | 55,574,828 | 14,916,765 | 16,946,353 | 58,045,562 | 66,995,690 | 13% | 15% | 11% | 21% | 17,520,003 | 20,063,147 | 69,232,017 | 80,162,177 | 17% | 18% | 19% | 20% |
| | | | | | | | | | | | | | | | | | | | | |
| | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
| Vehicle-Hours Traveled | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period |
| Freeway | 129,919 | 141,594 | 484,550 | 574,929 | 154,200 | 174,722 | 557,785 | 666,013 | 19% | 23% | 15% | 16% | 199,161 | 230,329 | 712,039 | 906,153 | 29% | 32% | 28% | 36% |
| Expressway | 21,220 | 23,789 | 82,322 | 102,272 | 26,731 | 31,797 | 100,054 | 124,150 | 26% | 34% | 22% | 21% | 39,309 | 49,448 | 147,039 | 186,412 | 47% | 56% | 47% | 50% |
| Arterial/Local Streets | 201,118 | 263,899 | 622,034 | 844,028 | 245,325 | 310,400 | 734,449 | 1,014,682 | 22% | 18% | 18% | 20% | 360,339 | 479,279 | 1,017,284 | 1,494,349 | 47% | 54% | 39% | 47% |
| Ramps | 7,695 | 7,926 | 27,647 | 28,859 | 9,678 | 10,670 | 33,460 | 37,858 | 26% | 35% | 21% | 31% | 12,776 | 15,285 | 48,077 | 54,890 | 32% | 43% | 44% | 45% |
| All Facility Types | 359,952 | 437,208 | 1,216,553 | 1,550,088 | 435,934 | 527,589 | 1,425,748 | 1,842,703 | 21% | 21% | 17% | 19% | 611,585 | 774,341 | 1,924,439 | 2,641,804 | 40% | 47% | 35% | 43% |
| | | | | | | | | | | | | | | | | | | | | |
| | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
| Average Speed, MPH | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Hour | PM Peak Hour |
| Freeway | 49.0 | 48.9 | 50.4 | 47.5 | 45.9 | 44.2 | 48.3 | 45.2 | -6% | -9% | -4% | -5% | 39.5 | 37.5 | 42.4 | 37.4 | -14% | -15% | -12% | -17% |
| Expressway | 41.7 | 41.4 | 41.2 | 38.8 | 38.4 | 36.6 | 39.2 | 36.6 | -8% | -11% | -5% | -6% | 32.4 | 29.6 | 33.7 | 31.1 | -16% | -19% | -14% | -15% |
| Arterial/Local Streets | 28.6 | 25.0 | 37.7 | 27.8 | 26.6 | 24.9 | 35.7 | 30.8 | -7% | 0% | -5% | 11% | 22.4 | 20.1 | 32.4 | 26.2 | -16% | -20% | -9% | -15% |
| Ramps | 32.0 | 33.2 | 30.3 | 29.0 | 29.0 | 29.0 | 28.6 | 29.6 | -9% | -13% | -5% | 2% | 25.1 | 23.2 | 23.2 | 23.8 | -13% | -20% | -19% | -19% |
| All Facility Types | 36.8 | 33.8 | 42.8 | 35.9 | 34.2 | 32.1 | 40.7 | 36.4 | -7% | -5% | -5% | 1% | 28.6 | 25.9 | 36.0 | 30.3 | -16% | -19% | -12% | -17% |

## Table 7.12 Alameda County Vehicle-Miles-Traveled, Vehicle-Hours-Traveled and Average Speed, AM and PM Peak Hour and Period

| **Regional** | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle-Miles Traveled | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period |
| Freeway | 1,445,045 | 1,541,014 | 5,534,556 | 6,118,912 | 1,632,554 | 1,756,180 | 6,257,263 | 6,825,961 | 13% | 14% | 13% | 12% | 1,779,254 | 1,904,521 | 6,775,344 | 7,408,358 | 9% | 8% | 8% | 9% |
| Expressway | 81,654 | 84,209 | 338,827 | 357,960 | 116,188 | 125,620 | 460,111 | 491,410 | 42% | 49% | 36% | 37% | 161,709 | 184,376 | 645,974 | 741,200 | 39% | 47% | 40% | 51% |
| Arterial/Local Streets | 745,533 | 802,834 | 2,586,499 | 3,054,527 | 885,759 | 1,033,984 | 3,061,067 | 3,666,029 | 19% | 29% | 18% | 20% | 1,091,184 | 1,296,940 | 3,814,333 | 4,617,752 | 23% | 25% | 25% | 26% |
| Ramps | 58,249 | 62,413 | 208,933 | 239,046 | 66,961 | 72,244 | 244,396 | 275,703 | 15% | 16% | 17% | 15% | 77,376 | 83,421 | 288,479 | 321,288 | 16% | 15% | 18% | 17% |
| All Facility Types | 2,330,481 | 2,490,470 | 8,668,815 | 9,770,445 | 2,701,462 | 2,988,028 | 10,022,837 | 11,259,103 | 16% | 20% | 16% | 15% | 3,109,523 | 3,469,258 | 11,524,130 | 13,088,598 | 15% | 16% | 15% | 16% |

| | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle-Hours Traveled | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period |
| Freeway | 30,499 | 31,846 | 116,595 | 130,645 | 36,576 | 40,052 | 138,307 | 153,513 | 20% | 26% | 19% | 18% | 47,851 | 52,114 | 175,609 | 197,427 | 31% | 30% | 27% | 29% |
| Expressway | 2,252 | 2,176 | 10,039 | 9,367 | 3,334 | 3,912 | 12,796 | 13,049 | 48% | 80% | 27% | 39% | 5,359 | 6,414 | 23,035 | 21,342 | 61% | 64% | 80% | 64% |
| Arterial/Local Streets | 25,588 | 27,693 | 89,265 | 106,663 | 30,871 | 41,262 | 104,982 | 130,840 | 21% | 49% | 18% | 23% | 40,714 | 61,834 | 137,282 | 169,612 | 32% | 50% | 31% | 30% |
| Ramps | 2,208 | 2,028 | 9,319 | 7,938 | 2,615 | 2,572 | 11,699 | 11,595 | 18% | 27% | 26% | 46% | 3,518 | 3,810 | 20,152 | 18,717 | 35% | 48% | 72% | 61% |
| All Facility Types | 60,547 | 63,743 | 225,218 | 254,613 | 73,396 | 87,798 | 267,784 | 308,997 | 21% | 38% | 19% | 21% | 97,442 | 124,172 | 356,078 | 407,098 | 33% | 41% | 33% | 32% |

| | 2010 | | | | 2020 | | | | Growth 2010 to 2020 | | | | 2040 | | | | Growth 2020 to 2040 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Speed, MPH | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Period | PM Peak Period | AM Peak Hour | PM Peak Hour | AM Peak 4-Hour Period | PM Peak 4-Hour Period | AM Peak Hour | PM Peak Hour | AM Peak Hour | PM Peak Hour |
| Freeway | 47.4 | 48.4 | 47.5 | 46.8 | 44.6 | 43.8 | 45.2 | 44.5 | -6% | -9% | -5% | -5% | 37.2 | 36.5 | 38.6 | 37.5 | -17% | -17% | -15% | -16% |
| Expressway | 36.3 | 38.7 | 33.8 | 38.2 | 34.8 | 32.1 | 36.0 | 37.7 | -4% | -17% | 7% | -1% | 30.2 | 28.7 | 28.0 | 34.7 | -13% | -10% | -22% | -8% |
| Arterial/Local Streets | 29.1 | 29.0 | 29.0 | 28.6 | 28.7 | 25.1 | 29.2 | 28.0 | -2% | -14% | 1% | -2% | 26.8 | 21.0 | 27.8 | 27.2 | -7% | -16% | -5% | -3% |
| Ramps | 26.4 | 30.8 | 22.4 | 30.1 | 25.6 | 28.1 | 20.9 | 23.8 | -3% | -9% | -7% | -21% | 22.0 | 21.9 | 14.3 | 17.2 | -14% | -22% | -31% | -28% |
| All Facility Types | 38.5 | 39.1 | 38.5 | 38.4 | 36.8 | 34.0 | 37.4 | 36.4 | -4% | -13% | -3% | -5% | 31.9 | 27.9 | 32.4 | 32.2 | -13% | -18% | -14% | -12% |

**Table 7.13 Regional Daily Vehicle-Miles-Traveled, Vehicle-Hours-Traveled and Average Speed**

| Regional Vehicle-Miles Traveled | 2010 Daily | 2020 Daily | Growth 2010 to 2020 | 2040 Daily | Growth 2010 to 2040 |
|---|---|---|---|---|---|
| Freeway | 94,967,097 | 104,729,320 | 10.3% | 118,784,325 | 25.1% |
| Expressway | 11,444,400 | 13,037,083 | 13.9% | 16,680,936 | 45.8% |
| Arterial/Local Streets | 56,538,145 | 63,658,150 | 12.6% | 76,184,173 | 34.7% |
| Ramps | 3,236,766 | 3,686,895 | 13.9% | 4,265,802 | 31.8% |
| All Facility Types | 166,186,408 | 185,111,448 | 11.4% | 215,915,236 | 29.9% |
| **Regional Vehicle-Hours Traveled** | **2010 Daily** | **2020 Daily** | **Growth 2010 to 2020** | **2040 Daily** | **Growth 2010 to 2040** |
| Freeway | 1,840,211 | 2,123,964 | 15.4% | 2,732,270 | 48.5% |
| Expressway | 272,085 | 324,362 | 19.2% | 465,239 | 71.0% |
| Arterial/Local Streets | 2,328,880 | 2,742,380 | 17.8% | 3,783,154 | 62.4% |
| Ramps | 97,422 | 122,639 | 25.9% | 161,705 | 66.0% |
| All Facility Types | 4,538,598 | 5,313,345 | 17.1% | 7,142,368 | 57.4% |
| **Regional Average Speed, MPH** | **2010 Daily** | **2020 Daily** | **Growth 2010 to 2020** | **2040 Daily** | **Growth 2010 to 2040** |
| Freeway | 52 | 49 | -4.5% | 43 | -15.8% |
| Expressway | 42 | 40 | -4.4% | 36 | -14.8% |
| Arterial/Local Streets | 24 | 23 | -4.4% | 20 | -17.1% |
| Ramps | 33 | 30 | -9.5% | 26 | -20.6% |
| All Facility Types | 37 | 35 | -4.9% | 30 | -17.4% |

**Table 7.14 Alameda County Daily Vehicle-Miles-Traveled, Vehicle-Hours-Traveled and Average Speed**

| Alameda County | 2010 | 2020 | Growth | 2040 | Growth |
|---|---|---|---|---|---|
| **Vehicle-Miles Traveled** | **Daily** | **Daily** | **2010 to 2020** | **Daily** | **2010 to 2040** |
| Freeway | 22,010,480 | 24,796,017 | 12.7% | 27,058,131 | 22.9% |
| Expressway | 1,081,806 | 1,490,291 | 37.8% | 2,234,265 | 106.5% |
| Arterial/ Local Streets | 9,582,383 | 11,222,302 | 17.1% | 13,883,285 | 44.9% |
| Ramps | 815,723 | 939,113 | 15.1% | 1,106,088 | 35.6% |
| All Facility Types | 33,490,392 | 38,447,723 | 14.8% | 44,281,769 | 32.2% |
| **Alameda County** | **2010** | **2020** | **Growth** | **2040** | **Growth** |
| **Vehicle-Hours Traveled** | **Daily** | **Daily** | **2010 to 2020** | **Daily** | **2010 to 2040** |
| Freeway | 437,702 | 515,049 | 17.7% | 647,712 | 48.0% |
| Expressway | 28,120 | 37,024 | 31.7% | 63,237 | 124.9% |
| Arterial/Local Streets | 331,830 | 391,712 | 18.0% | 496,682 | 49.7% |
| Ramps | 27,973 | 36,965 | 32.1% | 56,973 | 103.7% |
| All Facility Types | 825,625 | 980,750 | 18.8% | 1,264,604 | 53.2% |
| **Alameda County** | **2010** | **2020** | **Growth** | **2040** | **Growth** |
| **Average Speed, MPH** | **Daily** | **Daily** | **2010 to 2020** | **Daily** | **2010 to 2040** |
| Freeway | 50 | 48 | -4.3% | 42 | -16.9% |
| Expressway | 38 | 40 | 4.6% | 35 | -8.2% |
| Arterial/Local Streets | 29 | 29 | -0.8% | 28 | -3.2% |
| Ramps | 29 | 25 | -12.9% | 19 | -33.4% |
| All Facility Types | 41 | 39 | -3.4% | 35 | -13.7% |

### 7.1.7 Transit Boardings

Table 7.15 summarizes output generated by the transit assignments models in the form of daily boardings by major transit operators serving Alameda County. All transit operators show an increase in daily boardings from the base year 2010, with BART showing the largest absolute increase in boardings and LAVTA showing the largest percent increase in riders from 2010 to 2040.

**Table 7.15 Daily Transit Boardings by Alameda County Operator**

| Operator | 2010 Model | 2020 Model | Growth between 2010 and 2020 Models | 2040 Model | Growth between 2010 and 2040 Models |
|---|---|---|---|---|---|
| BART | 344,479 | 443,769 | 29% | 669,852 | 73% |
| AC Transit Local Bus | 178,080 | 225,289 | 27% | 377,670 | 89% |
| AC Transit Transbay | 17,918 | 23,287 | 30% | 30,598 | 54% |
| LAVTA | 6,706 | 10,499 | 57% | 26,305 | 187% |
| Union City | 2,583 | 3,655 | 42% | 5,298 | 74% |
| Emery-go-Round | 9,890 | 14,329 | 45% | 23,060 | 92% |
| Dumbarton Express | 2,021 | 2,322 | 15% | 3,505 | 64% |
| ACE | 2,372 | 2,579 | 9% | 3,460 | 42% |
| Capitol Corridor | 1,668 | 2,781 | 67% | 3,848 | 78% |
| East Bay Ferry | 1,132 | 4,160 | 267% | 4,981 | 93% |
| AirBART/OAC | 1,388 | 4,579 | 230% | 8,470 | 155% |
| All | 568,237 | 737,249 | 30% | 1,157,047 | 57% |

# 8.0 Model Consistency Results

The purpose of this chapter is to list the deliverables requested by the Metropolitan Transportation Commission (MTC) to establish that the Alameda County Transportation Commission (Alameda CTC) travel demand models apply a regionally consistent model set for the development of travel demand forecasts. This specific checklist of product deliverables was defined by MTC in the 2013 County Congestion Management Plans: Updated MTC Guidance and Review Process Resolution No. 3000, Revised, Attachment B. The required checklist products listed below are included and described in detail in the Model Consistency Report attached as Appendix A:

Product 1 - Description of the Alameda CTC Model

Product 2 – Description of Demographic Forecasts

Product 3 – Comparison of ABAG County-level estimates for population, households, jobs and employed residents

Product 4 – Identification of Differences between CMA and ABAG Census tract level forecasts

Product 5 - Regional-Level Auto Operating Costs

Product 6 – Highway Network and Transit Network

Product 7 – Households by Number of Automobiles, by County

Product 8 – Number of Trips by Tour (Trip) Purpose

Product 9 – Average Trip Distance by Tour (Trip) Purpose

Product 10 – Journey to Work, County to County Usual Workplace

Product 11 – Region-Level Mode Share by Tour (Trip) Purpose

Product 12 – Region-level VMT and VHT by Facility Type and Time Period

Product 13 – Region-level Average Speed (VMT/VHT) by Facility Type and time Period

# 9.0 Performance Measures

The Alameda Countywide Travel Demand Model has been updated in 2014 to use demographic inputs consistent with the Metropolitan Transportation Commission (MTC) Plan Bay Area. The model update work was completed in July, 2014 by staff from the Santa Clara Valley Transportation Authority (VTA) under contract to Alameda CTC. The model has been validated to a 2010 base year and forecasts have been prepared for 2020 and 2040.

The Alameda CTC has requested tabulations of model outputs and performance measures in support of the documentation of the model update. The following performance measures are described and summarized below:

1. Vehicle Miles of Travel
2. Emissions Outputs
3. Transit Accessibility
4. Mode Shares
5. Transit Ridership
6. Travel Times
7. Miles of Congested Roads, Tabulation
8. Miles of Congested Roads, Maps
9. Origin-Destination Travel Times
10. Mean Highway Speeds

The following sections summarize the methodology and results for each deliverable. All maps of performance measure results will be uploaded directly to Alameda CTC's website separately.

## 9.1 Vehicle Miles of Travel

Vehicle-miles of travel (VMT) are tabulated as vehicle trips times distance traveled. The following tabulations were requested:

Tables of vehicle miles of travel (VMT) by county and jurisdiction, including total VMT, VMT per person and VMT per employee, for the three study years (2010, 2020, 2040).

Tabulations of total VMT, VMT per person and VMT per employee for each TAZ for the three study years, delivered in a format that can be joined to GIS layers for mapping by Alameda CTC.

Vehicle miles of travel for Alameda County and each jurisdiction are listed in Table 9.1 and Table 9.2.

### 9.2 Emissions Outputs

Vehicle emissions related to Alameda County trips are calculated using the EMFAC program maintained by the California Air Resources Board (ARB). A module was developed for the Alameda County travel model based on the EMFAC 2007 software. There is a more recent version, EMFAC 2011, but that version does not allow for a direct interface with the travel model. The EMFAC 2007 version is used for this analysis, which provides a reasonable comparative evaluation of emissions, but does not include the most current vehicle emissions factors. The countywide emissions (daily tons of GHG and PM 2.5) for each of the study years (2010, 2020, and 2040) are listed in Table 9.3.

### 9.3 Transit Accessibility

Transit accessibility is defined as the number of jobs within a certain number of minutes of travel time by transit. The deliverable for this task is:

- Tabulations of number of jobs within 60 minutes for each TAZ for the three study years, delivered in a format that can be joined to GIS layers for mapping by Alameda CTC.

The transit travel time is calculated as the minimum non-zero peak period walk-access transit time. It includes walk time, wait time, vehicle travel time and transfer times.

### 9.4 Mode Shares

Mode shares are based on daily person trips. The requested deliverables is:

Tables of trips and percentages by mode for the three study years, for trips produced by (residential end) and attracted to (non-residential end) Alameda County, for home-work trips and total trips.

The travel modes are summarized in Table 9.4.

### 9.5 Transit Ridership

Transit ridership is reported as the total boardings on transit operators serving Alameda County. The numbers represent the number of boardings on transit vehicles, which may be greater than the number of transit trips, as some passengers may board two or more transit vehicles while making one trip. The requested deliverables are:

Tables of total daily transit ridership by Alameda County transit operator for the three study years.

Tables of total daily systemwide transit ridership for BART and AC Transit for the three study years.

Daily transit ridership by operator is summarized in Table 9.5.

### 9.6 Travel Times

Tables of average travel times by trip purpose and mode, and by up to three time periods (daily, peak) for the three study years, as summarized in Table 9.6.

### 9.7 Miles of Congested Roads, Tabulation

Tables of total miles and miles of congested (volume/capacity > 1.00) roads by major facility type for the PM peak 4-hour period for the three study years. The total miles and miles of congested roads are summarized in Table 9.7.

### 9.8 Miles of Congested Roads, Maps

Maps in PDF format showing color codes related to link volume/capacity ratios for the PM 4-hour period for the three study years.

### 9.9 Origin-Destination Travel Times

Travel times between selected origins and destinations are calculated based on congested road speeds and the corresponding transit travel times on the congested road network. The transit travel times and A.M. peak driving times are based on the A.M. 4-hour peak period, while the P.M. peak driving times are based on the P.M. 4-hour peak period. The travel model does not specifically estimate transit travel times for the P.M. peak period (on the assumption that A.M. peak commute conditions provide the best estimate of travel decisions). Therefore, P.M. peak transit times are based on the A.M. peak transit travel times in the opposite direction. Travel times for the ten selected origin-destination pairs are summarized in Table 9.8.

### 9.10 Mean Highway Speeds

Average (mean) highway speeds are calculated by dividing total vehicle-miles of travel on Alameda County roads by the total vehicle-hours of travel on Alameda County roads. The mean speeds by time period are listed in Table 9.9. The mean speeds by facility type are also listed for the P.M. 4-hour peak period.

## Table 9.1 Alameda County Vehicle Miles of Travel – Population Based

| | Population | | | Daily VMT Produced | | | VMT per Capita | | |
|---|---|---|---|---|---|---|---|---|---|
| **Jurisdiction** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** |
| Alameda | 74,645 | 80,132 | 94,663 | 947,058 | 1,100,380 | 1,193,470 | 12.7 | 13.7 | 12.6 |
| Alameda County | 13,217 | 13,057 | 13,439 | 518,900 | 544,707 | 546,932 | 39.3 | 41.7 | 40.7 |
| Albany | 18,560 | 19,839 | 22,555 | 192,978 | 218,596 | 227,643 | 10.4 | 11.0 | 10.1 |
| Ashland | 21,389 | 23,164 | 27,477 | 281,471 | 311,671 | 328,251 | 13.2 | 13.5 | 11.9 |
| Berkeley | 113,021 | 121,036 | 140,157 | 987,443 | 1,134,585 | 1,187,459 | 8.7 | 9.4 | 8.5 |
| Castro Valley | 57,519 | 58,036 | 61,897 | 1,261,063 | 1,345,395 | 1,353,297 | 21.9 | 23.2 | 21.9 |
| Cherryland | 11,478 | 12,112 | 13,883 | 145,542 | 161,477 | 171,853 | 12.7 | 13.3 | 12.4 |
| Dublin | 46,312 | 49,991 | 68,299 | 915,396 | 1,147,879 | 1,451,972 | 19.8 | 23.0 | 21.3 |
| Emeryville | 10,098 | 13,585 | 21,077 | 84,142 | 136,643 | 189,591 | 8.3 | 10.1 | 9.0 |
| Fremont | 214,441 | 232,210 | 278,090 | 4,548,757 | 5,179,077 | 5,918,041 | 21.2 | 22.3 | 21.3 |
| Hayward | 149,589 | 164,627 | 193,933 | 2,462,582 | 2,869,870 | 3,197,578 | 16.5 | 17.4 | 16.5 |
| Livermore | 81,881 | 94,057 | 111,621 | 2,257,469 | 3,033,483 | 3,509,287 | 27.6 | 32.3 | 31.4 |
| Newark | 42,733 | 47,806 | 60,370 | 804,462 | 992,454 | 1,244,963 | 18.8 | 20.8 | 20.6 |
| Oakland | 391,463 | 441,881 | 546,799 | 4,254,239 | 4,995,656 | 5,291,598 | 10.9 | 11.3 | 9.7 |
| Piedmont | 10,708 | 10,905 | 11,306 | 166,481 | 178,000 | 173,615 | 15.5 | 16.3 | 15.4 |
| Pleasanton | 71,719 | 78,353 | 93,926 | 1,751,457 | 1,977,124 | 2,220,909 | 24.4 | 25.2 | 23.6 |
| San Leandro | 87,126 | 93,597 | 108,987 | 1,259,289 | 1,402,246 | 1,497,136 | 14.5 | 15.0 | 13.7 |
| San Lorenzo | 28,680 | 29,434 | 31,700 | 458,642 | 457,983 | 462,575 | 16.0 | 15.6 | 14.6 |
| Union City | 69,483 | 74,437 | 84,463 | 1,491,727 | 1,662,463 | 1,869,791 | 21.5 | 22.3 | 22.1 |
| **Total** | 1,514,062 | 1,658,259 | 1,984,642 | 24,789,099 | 28,849,688 | 32,035,961 | 16.4 | 17.4 | 16.1 |

## Table 9.2 Alameda County Vehicle Miles of Travel - Employment Based

| | Employment | | | Daily VMT Produced | | | VMT per Capita | | |
|---|---|---|---|---|---|---|---|---|---|
| **Jurisdiction** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** | **2010** | **2020** | **2040** |
| Alameda | 24,376 | 29,398 | 34,642 | 947,486 | 1,042,621 | 1,251,945 | 38.9 | 35.5 | 36.1 |
| Alameda County | 3,976 | 4,845 | 5,754 | 276,065 | 307,651 | 363,925 | 69.4 | 63.5 | 63.2 |
| Albany | 4,345 | 4,747 | 5,747 | 203,045 | 208,430 | 246,263 | 46.7 | 43.9 | 42.9 |
| Ashland | 2,455 | 3,870 | 5,063 | 130,014 | 169,675 | 214,797 | 53.0 | 43.8 | 42.4 |
| Berkeley | 77,546 | 86,827 | 100,416 | 1,937,905 | 1,991,254 | 2,449,275 | 25.0 | 22.9 | 24.4 |
| Castro Valley | 11,098 | 14,422 | 16,114 | 557,826 | 640,615 | 703,512 | 50.3 | 44.4 | 43.7 |
| Cherryland | 1,464 | 2,045 | 2,381 | 68,415 | 83,109 | 95,689 | 46.7 | 40.6 | 40.2 |
| Dublin | 16,963 | 23,911 | 33,103 | 506,565 | 637,012 | 848,005 | 29.9 | 26.6 | 25.6 |
| Emeryville | 16,358 | 20,082 | 23,778 | 480,739 | 543,694 | 656,799 | 29.4 | 27.1 | 27.6 |
| Fremont | 86,604 | 108,240 | 127,319 | 2,530,818 | 2,982,896 | 3,447,131 | 29.2 | 27.6 | 27.1 |
| Hayward | 68,919 | 78,481 | 87,065 | 2,229,666 | 2,486,371 | 2,861,031 | 32.4 | 31.7 | 32.9 |
| Livermore | 48,164 | 58,232 | 67,107 | 1,374,647 | 1,622,245 | 1,908,807 | 28.5 | 27.9 | 28.4 |
| Newark | 16,798 | 21,151 | 23,306 | 511,687 | 589,510 | 694,879 | 30.5 | 27.9 | 29.8 |
| Oakland | 189,058 | 238,303 | 280,493 | 5,391,419 | 6,434,888 | 7,868,441 | 28.5 | 27.0 | 28.1 |
| Piedmont | 2,045 | 2,102 | 2,425 | 98,449 | 94,198 | 106,926 | 48.1 | 44.8 | 44.1 |
| Pleasanton | 55,787 | 66,070 | 74,775 | 1,522,862 | 1,683,996 | 1,954,937 | 27.3 | 25.5 | 26.1 |
| San Leandro | 39,671 | 47,137 | 51,746 | 1,316,500 | 1,467,904 | 1,624,406 | 33.2 | 31.1 | 31.4 |
| San Lorenzo | 3,346 | 4,838 | 5,186 | 183,319 | 208,978 | 228,789 | 54.8 | 43.2 | 44.1 |
| Union City | 17,193 | 22,577 | 26,216 | 551,242 | 639,435 | 731,392 | 32.1 | 28.3 | 27.9 |
| **Total** | 686,166 | 837,278 | 972,636 | 20,818,669 | 23,834,481 | 28,256,948 | 30.3 | 28.5 | 29.1 |
| Alameda | 24,376 | 29,398 | 34,642 | 947,486 | 1,042,621 | 1,251,945 | 38.9 | 35.5 | 36.1 |

**Table 9.3 Alameda County Daily Emissions**

| Pollutant (tons/day) | 2010 | 2020 | 2040 |
|---|---|---|---|
| GHG CO2eq | 32,465.16 | 28,259.63 | 27,082.48 |
| PM 2.5 | 1.63 | 1.35 | 1.35 |

Note: Emissions calculations based on EMFAC 2007

### Table 9.4 Alameda County Mode Shares

| | 2010 | | 2020 | | 2040 | |
|---|---|---|---|---|---|---|
| **Mode** | **Trips** | **Percent** | **Trips** | **Percent** | **Trips** | **Percent** |
| **Home-Work Trips** | | | | | | |
| Drive Alone | 859,334 | 68.2% | 1,019,121 | 66.4% | 1,122,158 | 63.3% |
| Shared Ride 2 | 142,689 | 11.3% | 174,278 | 11.3% | 204,928 | 11.6% |
| Shared Ride 3+ | 48,243 | 3.8% | 61,716 | 4.0% | 75,341 | 4.2% |
| Transit Walk Access | 77,319 | 6.1% | 107,105 | 7.0% | 147,701 | 8.3% |
| Transit Drive Access | 79,983 | 6.3% | 107,555 | 7.0% | 133,425 | 7.5% |
| Bike | 12,328 | 1,0% | 15,923 | 1.0% | 24,445 | 1.4% |
| Walk | 41,720 | 3.3% | 50,608 | 3.3% | 65,161 | 3.7% |
| **TOTAL** | **1,261,615** | **100.0%** | **1,536,305** | **100.0%** | **1,773,160** | **100.0%** |
| **All Trips** | | | | | | |
| Drive Alone | 2,236,540 | 47.8% | 2,568,991 | 47.9% | 2,832,805 | 45.4% |
| Shared Ride 2 | 930,503 | 19.9% | 1,047,320 | 19.6% | 1,177,973 | 18.8% |
| Shared Ride 3+ | 700,205 | 15.0% | 789,329 | 14.7% | 932,251 | 14.9% |
| Transit Walk Access | 214,440 | 4.6% | 270,635 | 5.1% | 438,680 | 7.0% |
| Transit Drive Access | 92,546 | 2.0% | 123,873 | 2.3% | 159,288 | 2.5% |
| Bike | 88,632 | 1.9% | 99,348 | 1.9% | 120,016 | 1.9% |
| Walk | 409,011 | 8.8% | 454,904 | 8.5% | 594,369 | 9.5% |
| **TOTAL** | **4,671,876** | **100.0%** | **5,354,400** | **100.0%** | **6,255,382** | **100.0%** |

### Table 9.5 Alameda County Model Transit Ridership

| Transit Service | 2010 | 2020 | 2040 |
|---|---|---|---|
| ALAMEDA COUNTY SERVICES | | | |
| BART (Systemwide) | 344,461 | 443,748 | 669,836 |
| BART Oakland Airport Connector | 0 | 4,579 | 8,470 |
| AC Transit Local (Systemwide) | 177,473 | 224,700 | 377,165 |
| AC Transit Transbay | 17,873 | 23,256 | 30,592 |
| LAVTA/Wheels | 6,615 | 10,429 | 26,217 |
| East Bay Ferries | 1,131 | 8,340 | 19,134 |
| Union City | 2,544 | 3,621 | 5,283 |
| ACE Rail | 2,372 | 2,577 | 3,461 |
| Amtrak (Capitol, etc…) | 1,705 | 2,871 | 3,968 |
| AirBART | 1,388 | 0 | 0 |
| **Subtotal Alameda County** | **529,680** | **691,796** | **1,100,822** |
| OTHER TRANSIT SERVICES | | | |
| MUNI | 576,318 | 711,469 | 896,949 |
| SCVTA | 178,986 | 267,565 | 431,145 |
| SamTrans | 63,107 | 87,175 | 121,984 |
| Golden Gate Transit | 26,388 | 34,412 | 44,872 |
| CalTrain | 45,520 | 76,174 | 113,064 |
| CCCTA | 20,214 | 26,606 | 44,802 |
| Fairfield/Suisun | 6,174 | 9,435 | 13,332 |
| Vallejo Bus + Ferry | 8,902 | 14,281 | 18,950 |
| Sonoma County Providers | 40,612 | 49,250 | 64,783 |
| Tri-Delta Transit | 10,137 | 14,619 | 27,377 |
| Napa County Vine | 2,839 | 3,611 | 4,862 |
| WestCAT | 4,573 | 6,045 | 9,187 |
| eBART | 0 | 356 | 3,029 |
| Other | 53,298 | 74,879 | 118,977 |
| **Subtotal Other** | **1,037,068** | **1,375,877** | **1,913,313** |
| **TOTAL** | **1,566,748** | **2,067,673** | **3,014,135** |

**Table 9.6 Alameda County Average (Mean) Travel Times by Trip Purpose and Mode**

| Trip Purpose | Mode | 2010 | 2020 | 2040 |
|---|---|---|---|---|
| DAILY TRIPS | | | | |
| Home-Work | Drive Alone | 22.9 | 22.6 | 24.2 |
| | Shared Ride 2 | 27.0 | 27.3 | 30.5 |
| | Transit | 54.4 | 55.3 | 54.9 |
| Home-Shop | Drive Alone | 13.1 | 13.6 | 14.6 |
| | Shared Ride 2 | 12.9 | 13.5 | 14.7 |
| | Transit | 36.8 | 37.6 | 34.6 |
| Home-Social/Rec | Drive Alone | 14.3 | 15.1 | 16.7 |
| | Shared Ride 2 | 14.2 | 14.8 | 16.6 |
| | Transit | 50.1 | 53.0 | 48.5 |
| Non Home | Drive Alone | 14.4 | 14.2 | 15.7 |
| | Shared Ride 2 | 14.6 | 14.9 | 17.1 |
| | Transit | 41.5 | 44.6 | 40.9 |
| Home-School | Drive Alone | 9.3 | 8.4 | 16.2 |
| | Shared Ride 2 | 9.2 | 8.3 | 16.1 |
| | Transit | 41.3 | 39.8 | 50.2 |
| AM PEAK 4-HOUR | | | | |
| All Trips | Drive Alone | 18.5 | 18.6 | 20.3 |
| | Shared Ride | 17.1 | 17.9 | 20.9 |
| | Transit | 52.0 | 52.3 | 52.1 |
| PM PEAK 4-HOUR | | | | |
| All Trips | Drive Alone | 16.3 | 16.2 | 17.0 |
| | Shared Ride | 22.0 | 23.0 | 25.0 |

### Table 9.7 Alameda County Total and Congested Miles of Road

| Road Type | 2010 | 2020 | 2040 |
|---|---|---|---|
| **Freeway** | | | |
| Total Miles | 354.8 | 403.9 | 404.0 |
| Congested Miles | 8.9 | 18.1 | 31.7 |
| Percent Congested | 2.5% | 4.5% | 7.8% |
| **Expressway** | | | |
| Total Miles | 133.2 | 134.3 | 133.7 |
| Congested Miles | 5.8 | 6.0 | 25.3 |
| Percent Congested | 4.4% | 4.5% | 18.9% |
| **Arterial** | | | |
| Total Miles | 957.2 | 976.7 | 984.3 |
| Congested Miles | 6.2 | 7.6 | 16.6 |
| Percent Congested | 0.6% | 0.8% | 1.7% |
| **Collector** | | | |
| Total Miles | 1,238.0 | 1,240.6 | 1,243.0 |
| Congested Miles | 0.5 | 0.6 | 4.4 |
| Percent Congested | 0.0% | 0.0% | 0.4% |
| **All Roads** | | | |
| Total Miles | 4,057.9 | 4,149.4 | 4,162.7 |
| Congested Miles | 25.0 | 37.3 | 85.4 |
| Percent Congested | 0.6% | 0.9% | 2.1% |

Note: Congested miles are defined as miles of road with volumes exceeding the average segment capacity as defined in the Alameda County travel model during the P.M. 4-hour peak period.

### Table 9.8 Alameda County Model Origin-Destination Travel Times

| Origin-Destination Pair (TAZ) | 2010 | 2020 | 2040 |
|---|---|---|---|
| 1. Hayward (724) to Newark (920) – PM Peak | | | |
| Drive Alone | 11.9 | 12.1 | 13.7 |
| Shared Ride | 10.4 | 10.5 | 13.7 |
| Transit | 49.8 | 49.8 | 52.0 |
| 2. Emeryville (123) to Berkeley (19) – PM Peak | | | |
| Drive Alone | 8.9 | 9.1 | 10.2 |
| Shared Ride | 8.9 | 9.1 | 10.2 |
| Transit | 36.6 | 36.6 | 36.6 |
| 3. Hayward (706) to Livermore (1265) – PM Peak | | | |
| Drive Alone | 34.3 | 38.1 | 44.7 |
| Shared Ride | 33.2 | 37.6 | 44.7 |
| Transit | 112.4 | 110.8 | 105.3 |
| 4. Oakland (232) to San Leandro (533) – PM Peak | | | |
| Drive Alone | 18.3 | 19.0 | 21.2 |
| Shared Ride | 18.3 | 18.9 | 21.2 |
| Transit | 60.8 | 60.8 | 59.5 |
| 5. Fremont (898) to Pleasanton (1137) – PM Peak | | | |
| Drive Alone | 28.1 | 28.4 | 38.2 |
| Shared Ride | 28.1 | 22.7 | 38.2 |
| Transit | 110.4 | 82.9 | 80.6 |
| 6. Fremont (854) to San Jose (2910) – AM Peak | | | |
| Drive Alone | 21.8 | 22.9 | 23.9 |
| Shared Ride | 18.0 | 18.0 | 23.8 |
| Transit | 61.6 | 61.6 | 61.7 |
| 7. Fremont (854) to San Jose (2910) – PM Peak | | | |
| Drive Alone | 18.4 | 19.0 | 22.1 |
| Shared Ride | 17.7 | 17.7 | 22.1 |
| Transit | 79.4 | 65.5 | 62.2 |
| 8. Oakland (233) to Pleasanton (1137) – PM Peak | | | |
| Drive Alone | 37.3 | 42.6 | 51.7 |
| Shared Ride | 37.3 | 42.6 | 51.7 |
| Transit | 82.3 | 81.2 | 79.4 |
| 9. Fremont (854) to Alameda (513) – PM Peak | | | |
| Drive Alone | 30.3 | 30.9 | 32.6 |
| Shared Ride | 27.6 | 28.1 | 31.9 |
| Transit | 100.2 | 97.4 | 94.1 |

| Origin-Destination Pair (TAZ) | 2010 | 2020 | 2040 |
|---|---|---|---|
| 10. Alameda (475) to Oakland (137) – PM Peak | | | |
| Drive Alone | 11.8 | 13.4 | 16.3 |
| Shared Ride | 11.8 | 13.4 | 16.3 |
| Transit | 68.5 | 69.9 | 69.6 |

**Table 9.9 Average (Mean) Road Speeds by Time Period**

| | 2010 | | 2020 | | 2040 | |
|---|---|---|---|---|---|---|
| Time Period | Free Flow | Congested | Free Flow | Congested | Free Flow | Congested |
| Daily Average | 46.5 | 42.1 | 46.3 | 41.2 | 45.6 | 38.2 |
| AM Peak Hour | 45.1 | 35.8 | 44.7 | 34.3 | 44.1 | 30.0 |
| AM Peak 4-Hour Period | 45.7 | 37.2 | 45.3 | 35.9 | 44.6 | 31.5 |
| PM Peak Hour | 44.8 | 38.1 | 44.0 | 33.2 | 43.1 | 27.3 |
| PM Peak 4-Hour Period | 45.2 | 37.4 | 44.6 | 35.6 | 43.8 | 31.5 |
| Freeway | 63.0 | 47.2 | 63.1 | 44.7 | 63.0 | 37.7 |
| Expressway | 44.0 | 35.1 | 44.1 | 37.7 | 44.2 | 34.5 |
| Arterial | 33.1 | 31.5 | 33.1 | 30.5 | 33.2 | 29.8 |
| Collector | 27.6 | 26.3 | 27.6 | 25.7 | 28.0 | 23.5 |

# Appendix A: MTC Modeling Consistency Documentation for the Updated Alameda Countywide Travel Demand Model

## MTC Modeling Consistency Documentation for

## The Updated Alameda Countywide Travel Demand Model

### Alameda County Transportation Commission

**October 28, 2014**

## Introduction

The purpose of this document (Model Consistency Report) is to provide the deliverables requested by the Metropolitan Transportation Commission (MTC) to establish that the Alameda County Transportation Commission (Alameda CTC) travel demand models apply a regionally consistent model set for the development of travel demand forecasts. The specific checklist of product deliverables was defined by MTC in the *2013 County Congestion Management Plans: Updated MTC Guidance and Review Process Resolution No. 3000, Revised*, Attachment B (attached to this report as Attachment 1). The required checklist products listed below are included and described in detail in this report.

Product 1 - Description of the Alameda CTC Model
Product 2 – Description of Demographic Forecasts
Product 3 – Comparison of ABAG County-level estimates for population, households, jobs and employed residents
Product 4 – Identification of Differences between CMA and ABAG Census tract level forecasts
Product 5 - Regional-Level Auto Operating Costs
Product 6 – Highway Network and Transit Network
Product 7 – Households by Number of Automobiles, by County
Product 8 – Number of Trips by Tour (Trip) Purpose
Product 9 – Average Trip Distance by Tour (Trip) Purpose
Product 10 – Journey to Work, County to County Usual Workplace
Product 11 – Region-Level Mode Share by Tour (Trip) Purpose
Product 12 – Region-level VMT and VHT by Facility Type and Time Period
Product 13 – Region-level Average Speed (VMT/VHT) by Facility Type and time Period

## Product 1

## Description of the ACTC Model

The current Alameda CTC model had its origin in the MTC Regional model BAYCAST-90.The current Alameda CTC model was revised to produce an updated base year 2000 calibration and 2010 validation with selected model enhancements. These enhancements included calibration of the auto ownership models to American Community Survey (ACS) 2005 county-level data, addition of bicycle network infrastructure (bike lanes and paths) in the networks, travel time skims, mode choice and bicycle assignments and development of a toll modeling procedure to estimate express lane vehicle volumes. The model was validated to year 2010 screenline volumes for the AM and PM peak hours, peak periods and daily, and to year 2010 observed transit boardings. The updated model incorporates the Plan Bay Area transportation investments and the Sustainable Communities Strategy land use. The update process was guided by a Task Force, which included staff from MTC modeling team.

## Consistency with MTC Model

As noted previously, the ACTC model was designed to be consistent with the previous MTC Travel Demand Model forecasting system BAYCAST-90 model. This section provides a general overview of the ACTC models and also describes several basic modeling characteristics that are shared between the models.

**Transportation Analysis Zones (TAZ's)** — The current ACTC model has a more refined zone system in Alameda County and immediately adjacent sections of Santa Clara and Contra Costa Counties than the MTC regional models. Additional zones were added to more accurately reflect and support the added roadway network and to provide more detail in transit rich corridors and dense central business districts. In all, an additional 24 zones were added in Santa Clara County, 73 zones in Contra Costa County and 1,580 zones in Alameda County. The new model maintains the use of MTC's zone system in the remaining six Bay Area counties, but enlarges the full model region and zones to include San Joaquin County.

**Highway Network and Transit Network** — The roadway network used by the ACTC model includes additional detail in Alameda and a portion of Santa Clara and Contra Costa Counties. The current ACTC model also includes detailed stop, station and route detail for the transit network in Alameda County, and maintains the MTC roadway and transit networks in the remaining Bay Area counties. San Joaquin County COG provided roadways for San Joaquin County, however, the detailed networks was simplified to match the coarser zone structure applied for that county. Express lane facilities, representing the MTC 2013 Plan Bay Area express lanes system for 2020 and 2040, were also coded in the network with a toll facility indicator based on the highway corridor segment and the direction of travel. Differential toll facility codes were required in order to apply specific toll rates to optimize utilization of the express lanes to preserve level-of-service for free carpool users.  The ACTC model also includes a representation of the bicycle network infrastructure in the base year and forecast years for Alameda County, explicitly representing existing and future bike lanes and bike paths in travel time development, mode choice and bicycle assignments.

**Capacities and Speed** — The current ACTC model incorporates the area type and assignment group classification system published by MTC in BAYCAST-90.

**Trip Purposes** — The current ACTC model uses the same trip purposes used in the BAYCAST-90 model and also uses additional trip purposes not modeled by MTC. ACTC model trip purposes consistent with MTC BAYCAST-90 include the following:

- Home-based work trips
- Home-based shop and other trips
- Home-based social/recreation trips
- Non-home-based trips
- Home-based school: grade school, high school, and college trips
- Light, medium and heavy duty internal to internal zone truck trips

The ACTC model uses MTC BAYCAST-90 trip generation equations for trip production and trip attraction functions for all trip purposes listed above. In order to address special markets not included in the MTC trip purposes, the ACTC model includes several additional trip purposes beyond those modeled by MTC, including:

- Air-passenger trips to Oakland International (OAK), San Francisco International (SFO) Airport and San Jose/Mineta International Airport (SJC) and
- Light, medium and heavy-duty external truck trips

**Market Segments** — The ACTC model adopts the BAYCAST-90 disaggregate travel demand model four income group market segments for the home-based work trip purpose in trip generation, distribution and mode choice. In addition, the ACTC model also maintains the three workers per household (0, 1 and 2+ workers) and three auto ownership markets (0, 1 and 2+ autos owned) used in the MTC worker/auto ownership models.  Trips by peak and off-peak time period are also stratified in the trip distribution, mode choice and highway and transit assignment models.

**External Trips** — The ACTC model uses a different approach for incorporating inter-regional commuting estimates than MTC. For external zones consistent with the MTC model, MTC interregional vehicle volumes were applied for base year 2000 and adjusted to the future by assuming a 1 percent growth rate per year. For external gateways from San Joaquin County, the incorporation of that county as internally modeled areas obviated the development of external vehicle volumes for those areas of the ACTC models.

**Pricing** — The ACTC model uses MTC pricing assumptions for transit fares, bridge tolls, parking charges, and auto operating costs as assumed in the current MTC's Plan Bay Area including the Sustainable Community Strategies (SCS). All prices are expressed in year 1990 dollar values in the models. The ACTC model also uses regional express lane toll charges for the AM and PM peak periods that are based on optimizing the level-of-service in the carpool lanes. Depending on the level of utilization, these toll charges would vary by direction, time of day and by specific corridor.

**Auto Ownership** — The current ACTC model applies BAYCAST-90 for auto ownership models to estimate the number of households with 0, 1, and 2+ autos by four income groups in each traffic analysis zone. Walk to transit accessibility measures were incorporated in the auto ownership models consistent with MTC BAYCAST-90 to more logically associate low auto ownership households with transit services. The auto ownership models were recently calibrated to the 2005-2009 American Community Survey to match workers per household and auto ownership by county.

**Mode Choice** — The mode choice models for BAYCAST-90 include the use of nested structures for most trip purposes, however, explicit estimation of nested structures to consider transit submodes were not included in the model specification.[2] The ACTC model adds a nesting structure for transit submodes of local bus, express bus, light rail, heavy rail and commuter rail underneath the MTC BAYCAST-90 nested structures. Consistent with the BAYCAST-90, mode choice coefficients are preserved by constraining the model to the BAYCAST-90 parameters, except those in transit submode structure.[3]

**Peak Hour and Peak Periods for Highway Assignments** —The highway assignments produce AM and PM peak hour volumes(7:30 to 8:30AM and 4:30 to 5:30PM respectively), AM and PM peak period volumes (6 AM to 10 AM and 3 PM to 7 PM, respectively), midday volumes (10 AM to 3 PM) and evening volumes (7 PM to 6 AM). The four time period volumes are then added together to develop daily vehicle volumes.

**Vehicle and Transit Assignments** — The current ACTC model incorporates a methodology analogous to the MTC "layered," equilibrium assignment process, which distinguishes standard mixed-flow lanes from high-occupancy-vehicle (HOV) lanes. The equilibrium assignment process used in the current ACTC model is functionally equivalent to the MTC methodology. The ACTC model includes additional vehicle classes in the highway assignments for park-and-ride vehicles and drive-alone and carpool/toll vehicles.

Drive-alone and carpool/ toll vehicles for AM and PM peak periods are estimated using a toll model post-processor that estimates toll volumes based on a comparison of the non-toll and toll travel times and costs. This procedure assumes that toll choice occurs after the decision to choose auto versus transit has already been considered, and therefore does not influence transit mode choice. A toll choice constant for drive-alone and carpool modes was developed based on a calibration of toll volumes estimated by application of the toll model to the I-680 Express Lane facility and comparison of estimated to observed express lane volumes. It should be noted that by 2040, in order to maintain the operational

[2] A nested structure partitions the alternatives into groups (nests) of similarity. The groups can be further generalized into subgroups (subnests) and so on, which has the form of an inversed tree.

feasibility of implementing regional express toll lanes, it was assumed that only 3+ occupant carpools would be allowed to travel in the carpool lanes for free, consistent with Plan Bay Area. This was assumed for all carpool facilities in the ACTC model region, except those facilities that do not have proposed Express Lanes.

In the current ACTC model, transit passengers are assigned with a methodology analogous to that used by MTC, with separate assignments for each transit submode and access mode. Assignments are also performed separately for peak and off-peak conditions. A total of thirteen separate transit assignments are run to cover the full combination of transit submode and access modes as well as to estimate transit ridership for air-passengers.

**Model Validation with 2010 Traffic and Transit Volumes** — The current ACTC model is validated to year 2010 traffic volumes for county-level screenlines. Five time periods are validated for county screenlines: AM peak hour (7:30 to 8:30 AM), AM peak period (6 AM to 10 AM), PM peak hour (4:30 to 5:30),PM peak period (3 PM to 7 PM) and daily. Daily transit boardings were validated for the year 2010 at the system level for major regional transit operators (Caltrain, BART, MUNI, VTA and AC Transit) and at the route level for Alameda County transit operators.

## Product 2

## Description of Demographic Forecasts

The ACTC model uses the Association of Bay Area Governments (ABAG) Plan Bay Area Projections 2013 data series, which is adopted as the Sustainable Communities Strategy in the Plan Bay Area, for the base year 2010, 2020 and 2040. The MTC zone level allocations were sub-allocated to the smaller ACTC zones (including finer zones for both Alameda and part of Santa Clara and Contra Costa counties) based on local development information and census block level data. Therefore, the ACTC socioeconomic data inputs stay within the consistency allowances at the city jurisdiction control totals, however, slight differences do exist in parts of Santa Clara and Contra Costa Counties due to rounding errors resulting from the allocation process. Key ABAG land use variables used in the ACTC models do not differ by more than one percent at the county level for any of the 9 MTC region counties. No differences exist at the census tract level outside of Alameda County for any of the remaining MTC counties.

## Product 3

## ABAG County-Level Estimates for Population, Households, Jobs, and Employed Residents Year 2010, Plan Bay Area (v 0.3)

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 805,232 | 345,809 | 550,363 | 384,994 |
| San Mateo | 718,454 | 257,837 | 331,931 | 310,293 |
| Santa Clara | 1,781,640 | 604,205 | 811,902 | 738,391 |
| Alameda | 1,510,262 | 545,139 | 686,981 | 674,895 |
| Contra Costa | 1,049,041 | 375,364 | 352,870 | 462,499 |
| Solano | 413,339 | 141,758 | 132,345 | 185,491 |
| Napa | 136,480 | 48,876 | 61,748 | 61,904 |
| Sonoma | 483,885 | 185,825 | 177,617 | 223,901 |
| Marin | 252,408 | 103,210 | 114,864 | 110,899 |
| Bay Area | 7,150,741 | 2,608,023 | 3,220,621 | 3,153,267 |

### ACTC Trip-based Models

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 805,232 | 345,809 | 550,363 | 384,994 |
| San Mateo | 718,454 | 257,837 | 331,931 | 310,293 |
| Santa Clara | 1,781,640 | 604,205 | 811,902 | 738,391 |
| Alameda | 1,514,534 | 546,380 | 684,247 | 676,613 |
| Contra Costa | 1,049,041 | 375,364 | 352,870 | 462,499 |
| Solano | 413,339 | 141,758 | 132,345 | 185,491 |
| Napa | 136,480 | 48,876 | 61,748 | 61,904 |
| Sonoma | 483,885 | 185,825 | 177,617 | 223,901 |
| Marin | 252,408 | 103,210 | 114,864 | 110,899 |
| Bay Area | 7,155,013 | 2,609,264 | 3,217,887 | 3,154,985 |

### Percent Difference

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 0.00% | 0.00% | 0.00% | 0.00% |
| San Mateo | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Clara | 0.00% | 0.00% | 0.00% | 0.00% |
| Alameda | 0.28% | 0.23% | -0.40% | 0.25% |
| Contra Costa | 0.00% | 0.00% | 0.00% | 0.00% |
| Solano | 0.00% | 0.00% | 0.00% | 0.00% |
| Napa | 0.00% | 0.00% | 0.00% | 0.00% |
| Sonoma | 0.00% | 0.00% | 0.00% | 0.00% |
| Marin | 0.00% | 0.00% | 0.00% | 0.00% |
| Bay Area | 0.06% | 0.05% | -0.08% | 0.05% |

## Product 3, continued

## ABAG County-Level Estimates for Population, Households, Jobs, and Employed Residents Year 2040, Plan Bay Area (v 0.3)

### MTC Tour-based Models

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 1,076,365 | 447,340 | 759,515 | 559,923 |
| San Mateo | 898,704 | 315,094 | 445,047 | 445,591 |
| Santa Clara | 2,407,473 | 818,385 | 1,229,588 | 1,158,405 |
| Alameda | 1,965,356 | 705,337 | 947,664 | 891,473 |
| Contra Costa | 1,328,458 | 464,151 | 467,342 | 579,757 |
| Solano | 494,363 | 168,706 | 179,933 | 224,059 |
| Napa | 158,792 | 56,312 | 89,550 | 69,450 |
| Sonoma | 591,546 | 220,740 | 257,499 | 284,856 |
| Marin | 274,489 | 112,046 | 129,144 | 136,554 |
| Bay Area | 9,195,546 | 3,308,111 | 4,505,282 | 4,350,068 |

### ACTC Trip-based Models

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 1,076,365 | 447,340 | 759,515 | 559,923 |
| San Mateo | 898,704 | 315,094 | 445,047 | 445,591 |
| Santa Clara | 2,407,473 | 818,385 | 1,229,588 | 1,158,405 |
| Alameda | 1,980,038 | 709,371 | 956,964 | 895,526 |
| Contra Costa | 1,328,458 | 464,151 | 467,342 | 579,757 |
| Solano | 494,363 | 168,706 | 179,933 | 224,059 |
| Napa | 158,792 | 56,312 | 89,550 | 69,450 |
| Sonoma | 591,546 | 220,740 | 257,499 | 284,856 |
| Marin | 274,489 | 112,046 | 129,144 | 136,554 |
| Bay Area | 9,210,228 | 3,312,145 | 4,514,582 | 4,354,121 |

### Percent Difference

| County | Population | Households | Jobs | Employed Residents |
|---|---|---|---|---|
| San Francisco | 0.00% | 0.00% | 0.00% | 0.00% |
| San Mateo | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Clara | 0.00% | 0.00% | 0.00% | 0.00% |
| Alameda | 0.75% | 0.57% | 0.98% | 0.46% |
| Contra Costa | 0.00% | 0.00% | 0.00% | 0.00% |
| Solano | 0.00% | 0.00% | 0.00% | 0.00% |
| Napa | 0.00% | 0.00% | 0.00% | 0.00% |
| Sonoma | 0.00% | 0.00% | 0.00% | 0.00% |
| Marin | 0.00% | 0.00% | 0.00% | 0.00% |
| Bay Area | 0.16% | 0.12% | 0.21% | 0.09% |

## Product 4

### Identification of Differences between CMA and ABAG Census Tract Level

ACTC socioeconomic data inputs are consistent at both the MTC zone level and the ABAG census tract level for the Plan Bay Area scenario for the year 2040. Data at the MTC zone level in Alameda was allocated to the smaller ACTC model zones using local land use development patterns, working within the constraint of 1 % deviation from the ABAG control totals for the County.

## Product 5

### Region-Level Auto Operating Cost, Key Transit Fares and Bridge Tolls
### Year 2040, Plan Bay Area (v 0.3)

### MTC Tour-based Models

| Pricing Assumption | 2040 Value in 2000 dollars | 2040 Value in 2010 dollars |
|---|---|---|
| Auto Operating Cost per Mile | $0.222 | $0.280 |
| Bridge Tolls | Toll schedule starting July 1, 2012 | Toll schedule starting July 1, 2012 |
| Transit Fares | --- | --- |
| Muni Local Bus | $1.606 | $2.000 |
| AC Transit Local Bus | $1.606 | $2.000 |
| ACTC Local Bus | $1.606 | $2.000 |
| SamTrans Local Bus | $1.606 | $2.000 |

### ACTC Trip-based Models

| Pricing Assumption | 2040 Value in 2000 dollars[4] | 2040 Value in 2010 dollars[5] |
|---|---|---|
| Auto Operating Cost per Mile | $0.22 | $0.28 |
| Bridge Tolls | Toll schedule starting July 1, 2010 | Toll schedule starting July 1, 2010 |
| Transit Fares | --- | --- |
| Muni Local Bus | $1.606 | $2.00 |
| AC Transit Local Bus | $1.606 | $2.00 |
| ACTC Local Bus | $1.606 | $2.00 |
| SamTrans Local Bus | $1.606 | $2.00 |

[4] Source for Inflation Rates : http://www.bls.gov/data/inflation_calculator.htm

[5] Source for Inflation Rates : http://www.bls.gov/data/inflation_calculator.htm

## Product 6

**Highway Network and Transit Network** — The roadway network used by the ACTC model includes additional detail in Alameda County, and adjacent parts of Santa Clara and Contra Costa Counties. The current ACTC model also includes detailed stop, station and route detail in the transit network for Alameda County, and maintains the MTC roadway and transit networks in the remaining Bay Area counties. San Joaquin County COG provided roadways for San Joaquin County, however, the detailed networks was simplified to match the coarser zone structure assumed for San Joaquin County.

For model consistency reporting purposes, the ACTC models assumes all projects included in the 2040 Plan Bay Area Regional Transportation Plan in Alameda County and all other counties. The 2040 forecasts produced by the ACTC models also assumes, consistent with MTC model, that only 3+ person carpools are allowed to travel in the carpool lanes without a charge for the entire model region. The ACTC model includes a representation of the bicycle network infrastructure in the 2010 base year and 2020 and 2040 forecast years for Alameda County.

**Product 7**
**Households by Number of Automobiles, by County**
**Year 2040, Plan Bay Area (v 0.3)**

## MTC Tour-based Models

| County | Zero | One | Two + | Total | Zero | One | Two + | Total |
|---|---|---|---|---|---|---|---|---|
| San Francisco | 160,690 | 192,192 | 116,364 | 441,240 | 30.1% | 43.6% | 26.4% | 100.0% |
| San Mateo | 19,114 | 116,608 | 198,216 | 333,636 | 5.6% | 35.0% | 59.4% | 100.0% |
| Santa Clara | 66,300 | 268,396 | 528,788 | 859,448 | 7.2% | 31.2% | 61.5% | 100.0% |
| Alameda | 97,838 | 235,696 | 415,844 | 738,368 | 11.8% | 31.9% | 56.3% | 100.0% |
| Contra Costa | 19,860 | 153,448 | 317,904 | 491,212 | 4.0% | 31.2% | 64.7% | 100.0% |
| Solano | 10,868 | 50,216 | 121,300 | 182,384 | 6.0% | 27.5% | 66.5% | 100.0% |
| Napa | 4,044 | 19,240 | 37,200 | 60,484 | 6.7% | 31.8% | 61.5% | 100.0% |
| Sonoma | 14,996 | 68,860 | 146,316 | 230,172 | 6.5% | 29.9% | 63.6% | 100.0% |
| Marin | 6,992 | 43,332 | 72,116 | 122,440 | 5.7% | 35.4% | 58.9% | 100.0% |
| ALL | 357,348 | 1,147,988 | 1,954,048 | 3,459,384 | 10.3% | 33.2% | 56.5% | 100.0% |

## ACTC Trip-based Models

| County | Zero | One | Two + | Total | Zero | One | Two + | Total |
|---|---|---|---|---|---|---|---|---|
| San Francisco | 130,076 | 170,563 | 117,323 | 417,962 | 31.1% | 40.8% | 28.1% | 100.0% |
| San Mateo | 25,297 | 113,422 | 183,777 | 322,496 | 7.8% | 35.2% | 57.0% | 100.0% |
| Santa Clara | 73,775 | 250,650 | 501,913 | 826,338 | 8.9% | 30.3% | 60.7% | 100.0% |
| Alameda | 116,722 | 257,910 | 330,664 | 705,296 | 16.5% | 36.6% | 46.9% | 100.0% |
| Contra Costa | 33,991 | 159,328 | 287,157 | 480,476 | 7.1% | 33.2% | 59.8% | 100.0% |
| Solano | 8,270 | 49,035 | 113,991 | 171,296 | 4.8% | 28.6% | 66.5% | 100.0% |
| Napa | 2,771 | 17,703 | 34,167 | 54,641 | 5.1% | 32.4% | 62.5% | 100.0% |
| Sonoma | 13,600 | 75,388 | 123,801 | 212,789 | 6.4% | 35.4% | 58.2% | 100.0% |
| Marin | 5,004 | 41,293 | 64,354 | 110,651 | 4.5% | 37.3% | 58.2% | 100.0% |
| ALL | 409,506 | 1,135,292 | 1,757,147 | 3,301,945 | 12.4% | 34.4% | 53.2% | 100.0% |

**Product 8**
**Number of Trips by Tour Purpose**
**Year 2040, Plan Bay Area (v 0.3)**

## MTC Tour-based Models

| Purpose | Tour-based | Share |
|---|---|---|
| Work | 8,944,444 | 30.4% |
| University | 702,760 | 2.4% |
| School | 3,177,982 | 10.8% |
| At-Work | 1,981,510 | 6.7% |
| Eat Out | 1,245,114 | 4.2% |
| Escort | 2,828,588 | 9.6% |
| Shopping | 4,174,492 | 14.2% |
| Social | 936,416 | 3.2% |
| Other | 5,430,982 | 18.5% |
| ALL | 29,422,288 | 100.0% |

## ACTC Trip-based Models

| Purpose | Trip-based | Share |
|---|---|---|
| Home-based Work | 6,308,517 | 24.3% |
| Home-based Shopping/Other | 7,083,034 | 27.3% |
| Home-based Social-Recreational | 4,421,833 | 17.0% |
| Non-home-based | 5,678,273 | 21.9% |
| Home-based College | 530,688 | 2.1% |
| Home-based High School | 569,116 | 2.2% |
| Home-based Elementary School | 1,348,331 | 5.2% |
| ALL | 25,939,792 | 100.0% |

**Product 9**
**Average Trip Distance by Tour Purpose**
**Year 2040, Plan Bay Area (v 0.3)**

## MTC Tour-based Models

| Tour Purpose | Average Trip Distance, Miles |
|---|---|
| Work | 9.93 |
| University | 6.69 |
| School | 3.43 |
| At-Work | 3.29 |
| Eat Out | 5.44 |
| Escort | 4.36 |
| Shopping | 4.14 |
| Social | 4.98 |
| Other | 5.07 |
| All | 6.07 |

## ACTC Trip-based Models

| Trip Purpose | Average Trip Distance, Miles |
|---|---|
| Home-based Work | 12.75 |
| Home-based Shopping/Other | 5.22 |
| Home-based Social-Recreational | 7.02 |
| Non-home-based | 6.42 |
| Home-based College | 10.16 |
| Home-based High School | 6.77 |
| Home-based Elementary School | 2.88 |
| ALL | 7.51 |

## Product 10
## Journey to Work, County-to-County Usual Workplace
## Year 2040, Plan Bay Area (v 0.3)

### MTC Tour-based Models

| Origin County | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 436,968 | 56,868 | 7,632 | 40,904 | 8,850 | 1,042 | 452 | 1,140 | 9,798 | 563,654 |
| San Mateo | 95,390 | 231,982 | 73,666 | 36,932 | 5,788 | 588 | 204 | 588 | 4,204 | 449,342 |
| Santa Clara | 15,256 | 66,160 | 994,050 | 89,932 | 7,892 | 516 | 184 | 138 | 752 | 1,174,880 |
| Alameda | 99,626 | 52,964 | 103,474 | 556,862 | 68,510 | 3,924 | 1,368 | 972 | 6,268 | 893,968 |
| Contra Costa | 55,564 | 11,790 | 12,928 | 142,670 | 314,106 | 20,716 | 5,560 | 2,370 | 10,642 | 576,346 |
| Solano | 9,768 | 1,852 | 1,158 | 16,826 | 32,590 | 135,286 | 15,812 | 3,740 | 4,504 | 221,536 |
| Napa | 1,744 | 340 | 128 | 2,808 | 4,244 | 7,252 | 44,730 | 5,600 | 1,794 | 68,640 |
| Sonoma | 7,956 | 1,674 | 332 | 3,344 | 3,270 | 3,472 | 12,926 | 230,966 | 19,586 | 283,526 |
| Marin | 29,558 | 5,664 | 928 | 10,516 | 6,710 | 2,142 | 1,478 | 8,542 | 70,414 | 135,952 |
| Bay Area | 751,830 | 429,294 | 1,194,296 | 900,794 | 451,960 | 174,938 | 82,714 | 254,056 | 127,962 | 4,367,844 |

### ACTC Trip-based Models

| Origin County | San Francisco | San Mateo | Santa Clara | Alameda | Contra Costa | Solano | Napa | Sonoma | Marin | All |
|---|---|---|---|---|---|---|---|---|---|---|
| San Francisco | 458,159 | 53,553 | 15,931 | 18,118 | 4,865 | 421 | 338 | 1,186 | 7,352 | 559,923 |
| San Mateo | 105,360 | 264,048 | 57,927 | 12,274 | 2,065 | 330 | 218 | 580 | 2,698 | 445,501 |
| Santa Clara | 20,568 | 66,911 | 1,019,793 | 41,890 | 5,070 | 1,131 | 649 | 924 | 1,468 | 1,158,405 |
| Alameda | 104,454 | 38,687 | 65,144 | 633,798 | 40,003 | 3,140 | 888 | 3,108 | 6,304 | 895,526 |
| Contra Costa | 86,444 | 12,619 | 11,740 | 114,422 | 328,398 | 10,725 | 3,137 | 1,962 | 10,309 | 579,757 |
| Solano | 19,924 | 4,913 | 3,163 | 17,448 | 27,786 | 124,732 | 16,746 | 3,562 | 5,785 | 224,059 |
| Napa | 1,792 | 703 | 2,001 | 1,119 | 1,849 | 3,815 | 53,619 | 3,427 | 1,125 | 69,450 |
| Sonoma | 12,121 | 2,546 | 10,613 | 2,550 | 1,870 | 1,126 | 6,759 | 228,572 | 18,699 | 284,856 |
| Marin | 38,150 | 4,135 | 979 | 4,896 | 3,839 | 634 | 622 | 4,111 | 79,188 | 136,554 |
| Bay Area | 846,972 | 448,117 | 1,187,291 | 846,515 | 415,745 | 146,054 | 82,978 | 247,432 | 132,928 | 4,354,031 |

## Product 11
## Region-Level Mode Share by Tour Purpose
## Year 2040, Plan Bay Area (v 0.3)

### MTC Tour-based Models

| Tour Purpose | Automobile | Walk | Bicycle | Transit | All Modes |
|---|---|---|---|---|---|
| Work | 78.6% | 6.3% | 1.7% | 13.4% | 100.0% |
| University | 57.1% | 15.3% | 1.5% | 26.1% | 100.0% |
| School | 68.2% | 21.3% | 1.6% | 9.0% | 100.0% |
| At-Work | 67.4% | 30.7% | 0.8% | 1.0% | 100.0% |
| Eat Out | 78.7% | 16.5% | 1.2% | 3.6% | 100.0% |
| Escort | 94.5% | 5.0% | 0.2% | 0.3% | 100.0% |
| Shopping | 86.1% | 9.9% | 1.0% | 3.0% | 100.0% |
| Social | 76.1% | 16.1% | 1.6% | 6.2% | 100.0% |
| Other | 83.8% | 10.4% | 1.4% | 4.4% | 100.0% |
| All Purposes | 79.7% | 11.7% | 1.3% | 7.3% | 100.0% |

### ACTC Trip-based Models

| Trip Purpose | Automobile | Walk | Bicycle | Transit | All Modes |
|---|---|---|---|---|---|
| Home-based Work | 78.3% | 5.2% | 1.8% | 14.7% | 100.0% |
| Home-based Shopping/Other | 80.8% | 14.0% | 1.3% | 3.8% | 100.0% |
| Home-based Social-Recreational | 82.1% | 11.0% | 2.5% | 4.4% | 100.0% |
| Non-home-based | 77.4% | 15.9% | 1.2% | 5.5% | 100.0% |
| Home-based College | 66.6% | 11.1% | 1.6% | 21.3% | 100.0% |
| Home-based High School | 60.2% | 7.3% | 20.3% | 12.2% | 100.0% |
| Home-based Grade School | 66.0% | 27.5% | 3.1% | 11.7% | 100.0% |
| All Purposes | 77.7% | 12.3% | 2.1% | 7.9% | 100.0% |

# Product 12
# Region-Level VMT and VHT by Facility Type and Time Period
# Year 2040, Plan Bay Area (v 0.3)

## MTC Tour-based Models

### VMT

| | Facility Type | | | | | |
|---|---|---|---|---|---|---|
| Time Period | Freeways | Expressways | Major Arterials | Collectors | Other | All Facilities |
| Early AM (3 a.m. - 6 a.m.) | 5,490,922 | 555,072 | 1,191,716 | 334,311 | 348,451 | 7,920,472 |
| AM Peak (6 a.m. - 10 a.m.) | 26,225,898 | 2,866,727 | 9,845,537 | 2,781,418 | 3,332,966 | 45,052,546 |
| Midday (10 a.m. - 3 p.m.) | 26,438,610 | 3,022,363 | 10,998,863 | 2,825,048 | 4,296,401 | 47,581,284 |
| PM Peak (3 p.m. - 7 p.m.) | 27,989,269 | 3,246,036 | 11,965,076 | 3,294,279 | 4,294,782 | 50,789,442 |
| Evening (7 p.m. - 3 a.m.) | 16,749,237 | 1,790,134 | 5,799,274 | 1,556,541 | 2,158,192 | 28,053,377 |
| Daily | 102,893,935 | 11,480,332 | 39,800,466 | 10,791,597 | 14,430,791 | 179,397,121 |

**VHT**

| | Facility Type | | | | | |
|---|---|---|---|---|---|---|
| Time Period | Freeways | Expressways | Major Arterials | Collectors | Other | All Facilities |
| Early AM (3 a.m. - 6 a.m.) | 89,737 | 11,234 | 34,677 | 11,491 | 21,771 | 168,911 |
| AM Peak (6 a.m. - 10 a.m.) | 522,922 | 66,335 | 316,564 | 114,434 | 198,541 | 1,218,796 |
| Midday (10 a.m. - 3 p.m.) | 467,273 | 65,319 | 347,467 | 111,731 | 248,486 | 1,240,276 |
| PM Peak (3 p.m. - 7 p.m.) | 561,528 | 76,031 | 392,731 | 141,665 | 247,375 | 1,419,330 |
| Evening (7 p.m. - 3 a.m.) | 280,471 | 36,936 | 173,944 | 55,069 | 125,979 | 672,399 |
| Daily | 1,921,930 | 255,855 | 1,265,384 | 434,390 | 842,153 | 4,719,712 |

## ACTC Trip-based Models

### VMT

| | Facility Type | | | | | |
|---|---|---|---|---|---|---|
| Time Period | Freeways | Expressways | Major Arterials | Collectors | Other | All Facilities |
| AM Peak (6 a.m. - 10 a.m.) | 21,439,235 | 3,230,172 | 9,308,294 | 2,341,861 | 4,466,017 | 40,785,579 |
| Midday (10 a.m. - 3 p.m.) | 27,499,012 | 2,855,340 | 8,386,433 | 2,460,074 | 5,111,125 | 46,311,198 |
| PM Peak (3 p.m. - 7 p.m.) | 26,640,146 | 4,188,981 | 12,839,388 | 3,463,776 | 5,974,776 | 53,107,067 |
| Evening (7 p.m. - 6 a.m.) | 19,440,334 | 1,918,430 | 5,395,723 | 1,610,373 | 3,435,670 | 31,800,530 |
| Daily | 95,018,727 | 12,192,923 | 35,929,838 | 9,876,084 | 18,987,588 | 172,004,374 |

**VHT**

| | | | | | | Facility Type |
|---|---|---|---|---|---|---|
| Time Period | Freeways | Expressways | Major Arterials | Collectors | Other | All Facilities |
| AM Peak (6 a.m. - 10 a.m.) | 489,197 | 84,034 | 309,247 | 93,127 | 184,399 | 1,160,004 |
| Midday (10 a.m. - 3 p.m.) | 475,198 | 59,382 | 261,082 | 91,480 | 203,957 | 1,091,099 |
| PM Peak (3 p.m. - 7 p.m.) | 705,889 | 109,249 | 460,735 | 148,042 | 251,598 | 1,675,513 |
| Evening (7 p.m. - 6 a.m.) | 313,051 | 39,726 | 165,690 | 57,455 | 113,604 | 396,946 |
| Daily | 1,983,335 | 292,391 | 1,119,754 | 390,104 | 753,558 | 4,323,562 |

**Product 13**
**Region-Level Average Speed (VMT/VHT) by Facility Type and Time Period**
**Year 2040, Plan Bay Area (v 0.3)**

## MTC Tour-based Models

| | Facility Type | | |
|---|---|---|---|
| Time Period | Freeways | All Other Facilities | All Facilities |
| Early AM (3 a.m. - 6 a.m.) | 61.2 | 30.7 | 46.9 |
| AM Peak (6 a.m. - 10 a.m.) | 50.2 | 27.1 | 37.0 |
| Midday (10 a.m. - 3 p.m.) | 56.6 | 27.4 | 38.4 |
| PM Peak (3 p.m. - 7 p.m.) | 49.8 | 26.6 | 35.8 |
| Evening (7 p.m. - 3 a.m.) | 59.7 | 28.8 | 41.7 |
| Daily | 53.5 | 27.3 | 38.0 |

## ACTC Trip-based Models

| | Facility Type | | |
|---|---|---|---|
| Time Period | Freeways | All Other Facilities | All Facilities |
| AM Peak (6 a.m. - 10 a.m.) | 43.8 | 28.8 | 35.2 |
| Midday (10 a.m. - 3 p.m.) | 57.9 | 30.5 | 42.4 |
| PM Peak (3 p.m. - 7 p.m.) | 37.7 | 27.3 | 31.7 |
| Evening (7 p.m. - 6 a.m.) | 62.1 | 31.1 | 44.8 |
| Daily | 47.9 | 32.9 | 39.8 |